*FIG. 1a*

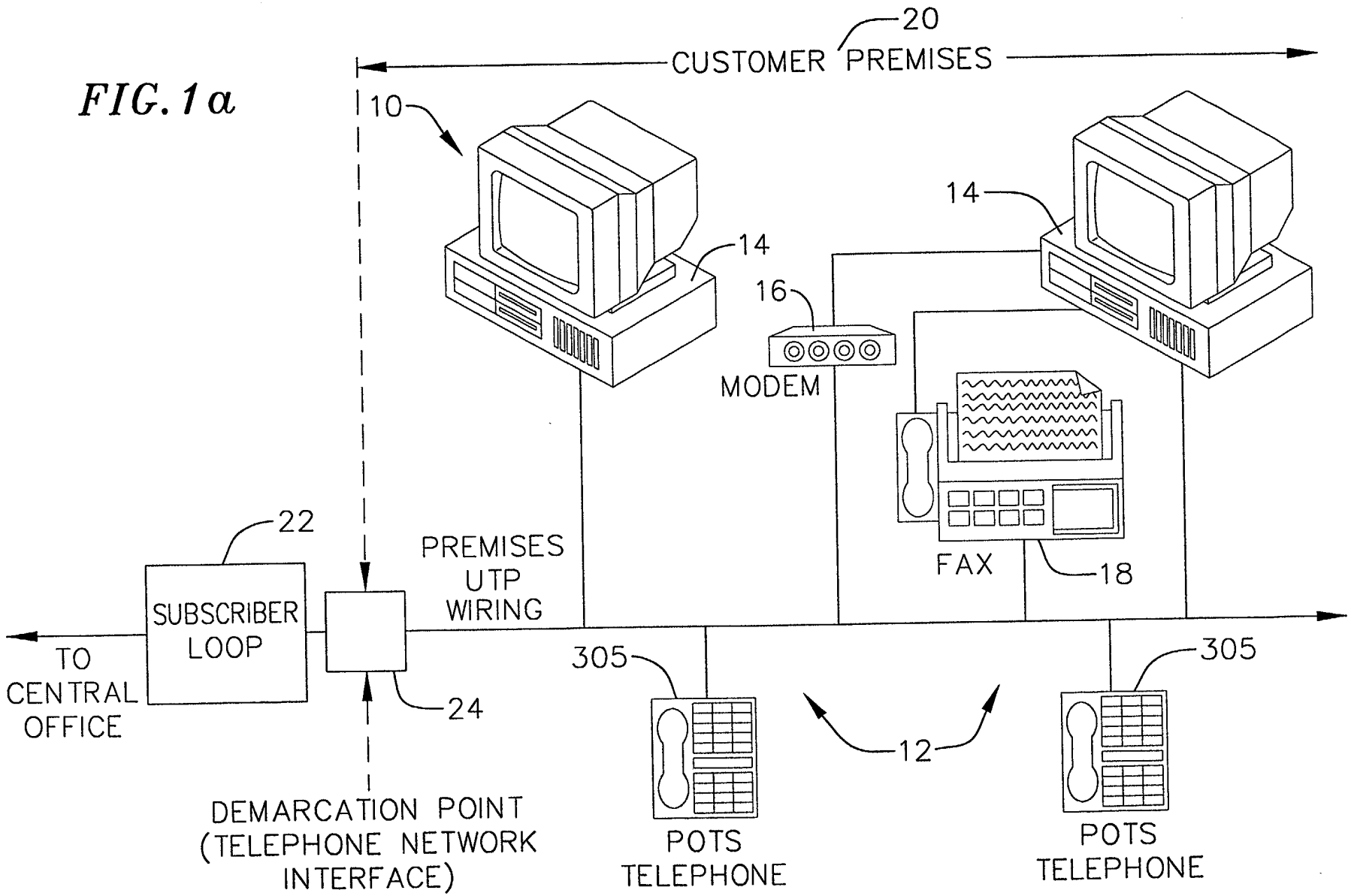

20
CUSTOMER PREMISES
10
14
14
16
MODEM
FAX
18
22
SUBSCRIBER LOOP
PREMISES UTP WIRING
TO CENTRAL OFFICE
24
305
305
12
DEMARCATION POINT (TELEPHONE NETWORK INTERFACE)
POTS TELEPHONE
POTS TELEPHONE

*FIG. 1b*

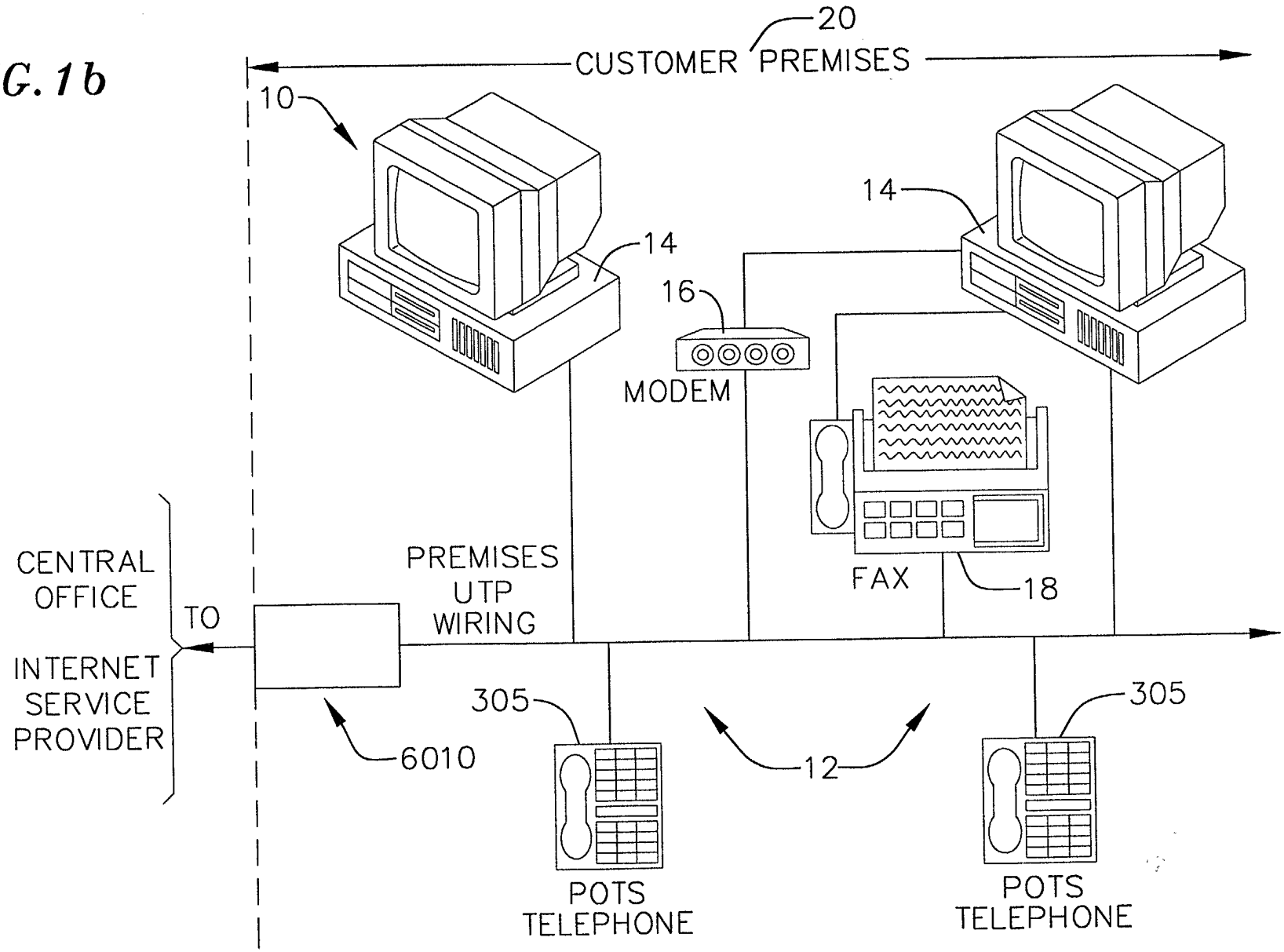

20
CUSTOMER PREMISES
10
14
14
16
MODEM
FAX
18
CENTRAL OFFICE
TO
INTERNET SERVICE PROVIDER
PREMISES UTP WIRING
305
305
6010
12
POTS TELEPHONE
POTS TELEPHONE

*FIG. 1c*

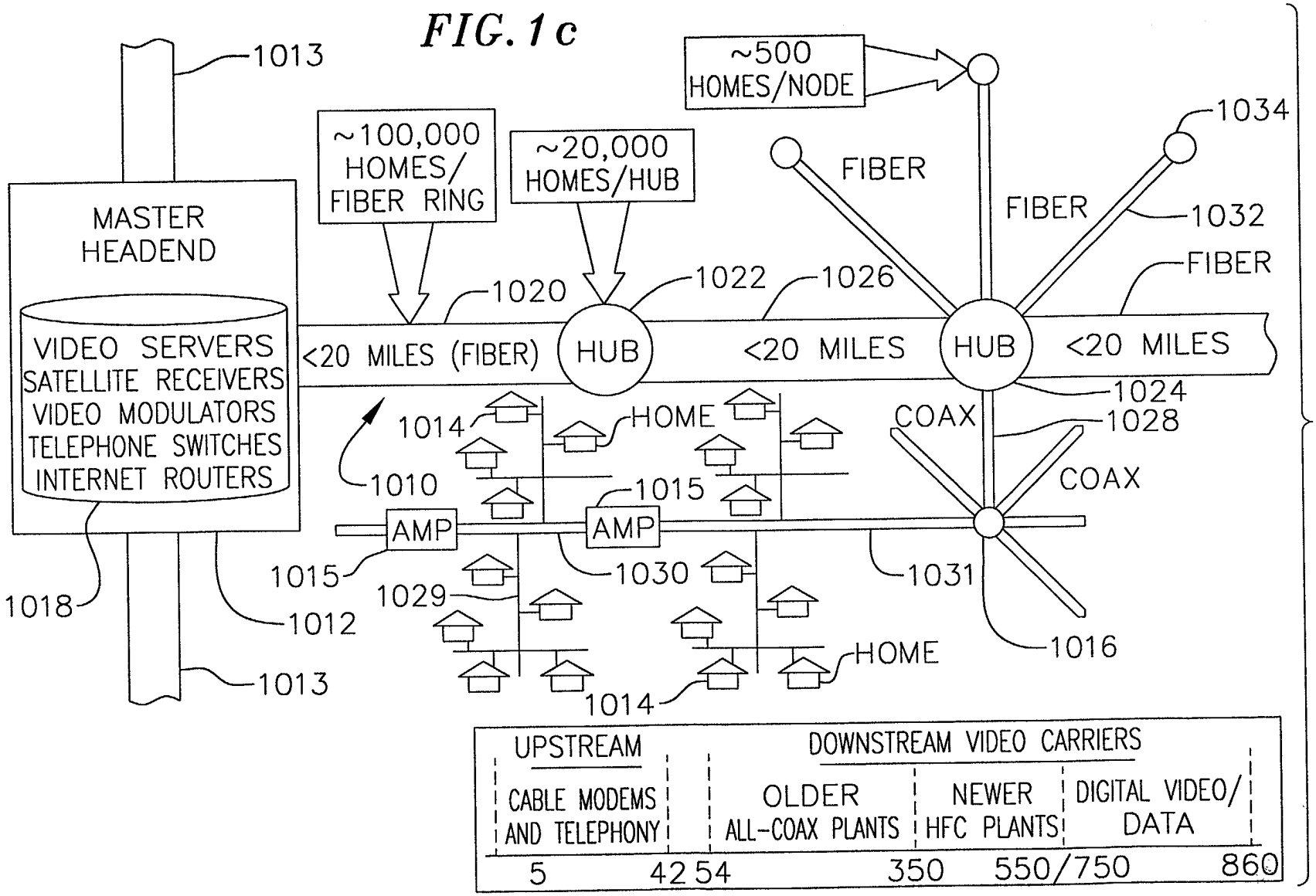

1013
~500 HOMES/NODE
1034
~100,000 HOMES/ FIBER RING
~20,000 HOMES/HUB
FIBER
FIBER
1032
FIBER
MASTER HEADEND
1020
1022
1026
VIDEO SERVERS
SATELLITE RECEIVERS
VIDEO MODULATORS
TELEPHONE SWITCHES
INTERNET ROUTERS
<20 MILES (FIBER)
HUB
<20 MILES
HUB
<20 MILES
1024
1014
HOME
COAX
1028
1010
1015
COAX
AMP
AMP
1015
1030
1031
1018
1029
1012
1016
HOME
1013
1014
UPSTREAM
DOWNSTREAM VIDEO CARRIERS
CABLE MODEMS AND TELEPHONY
OLDER ALL-COAX PLANTS
NEWER HFC PLANTS
DIGITAL VIDEO/ DATA
5
42 54
350
550/750
860

*FIG. 1d*

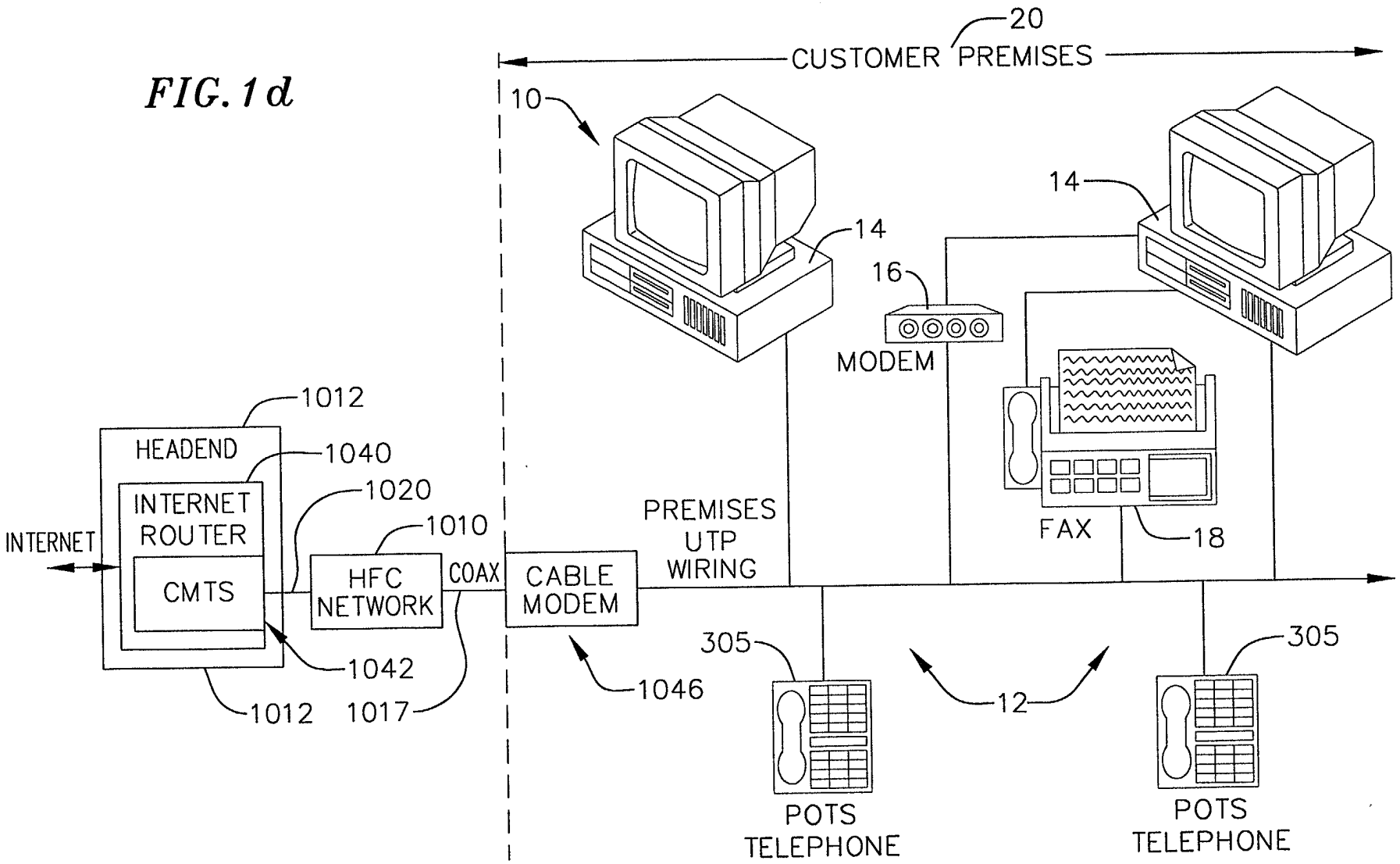

20
CUSTOMER PREMISES
10
14
14
16
MODEM
FAX
18
1012
HEADEND
1040
INTERNET ROUTER
1020
1010
INTERNET
CMTS
HFC NETWORK
COAX
CABLE MODEM
PREMISES UTP WIRING
1042
1012
1017
1046
305
305
12
POTS TELEPHONE
POTS TELEPHONE

*FIG.2*

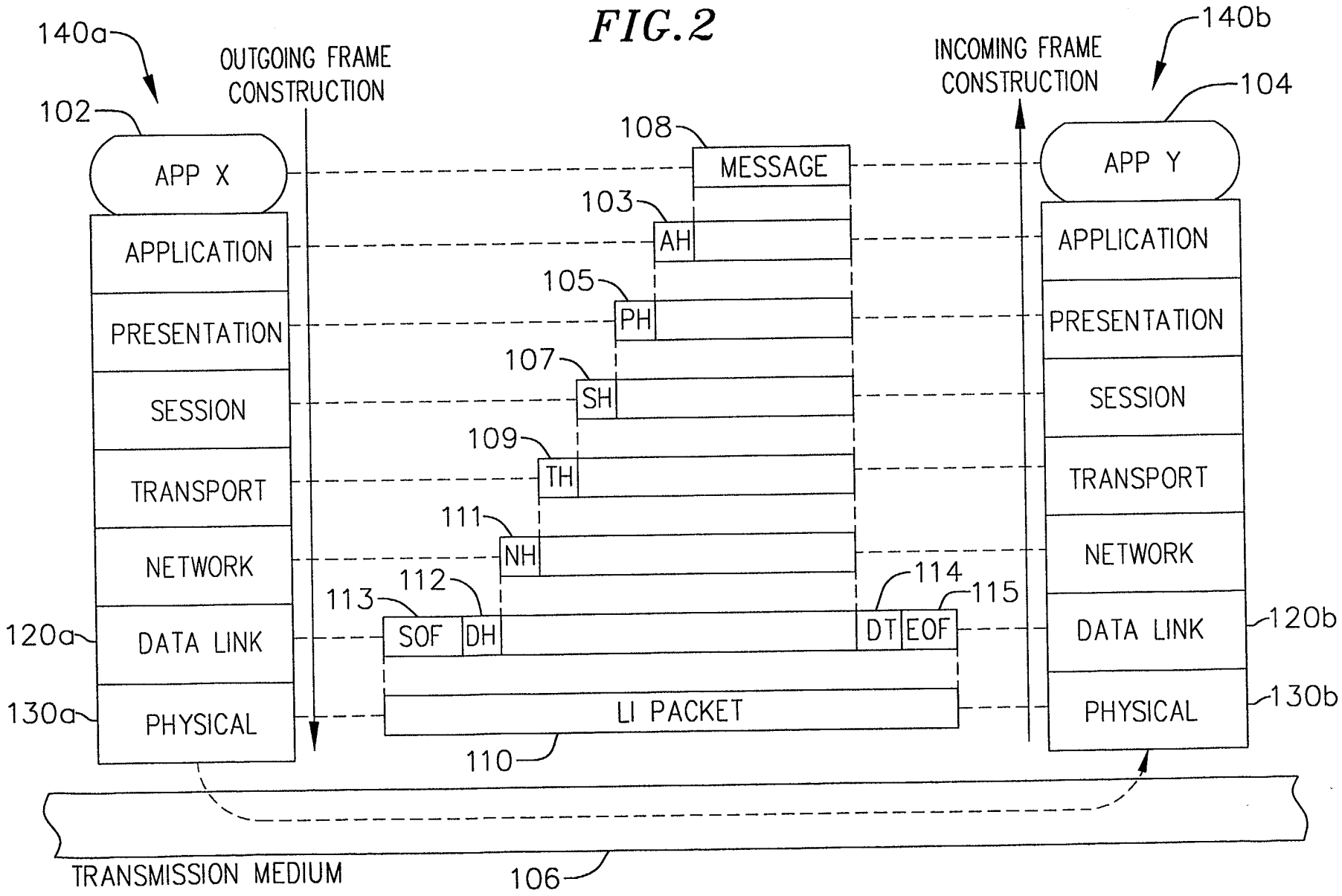

140a
OUTGOING FRAME CONSTRUCTION
102
APP X
APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK
PHYSICAL
120a
130a
108
MESSAGE
103
AH
105
PH
107
SH
109
TH
111
NH
112
113
SOF
DH
DT
114
EOF
115
LI PACKET
110
140b
INCOMING FRAME CONSTRUCTION
104
APP Y
APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK
PHYSICAL
120b
130b
TRANSMISSION MEDIUM
106

*FIG.3a*

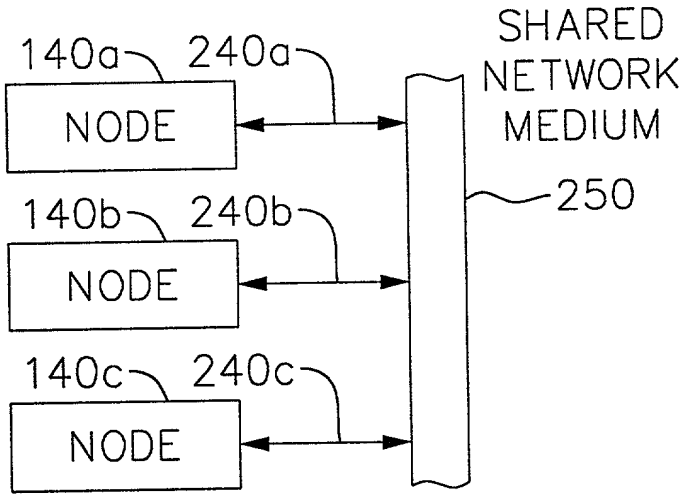

140a
240a
NODE
140b
240b
NODE
140c
240c
NODE
SHARED
NETWORK
MEDIUM
250

*FIG.3b*

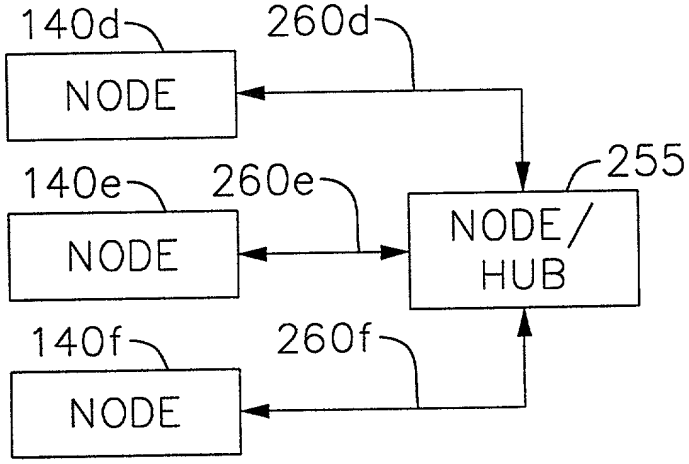

140d
260d
NODE
140e
260e
NODE
140f
260f
NODE
255
NODE/
HUB

*FIG. 4α*

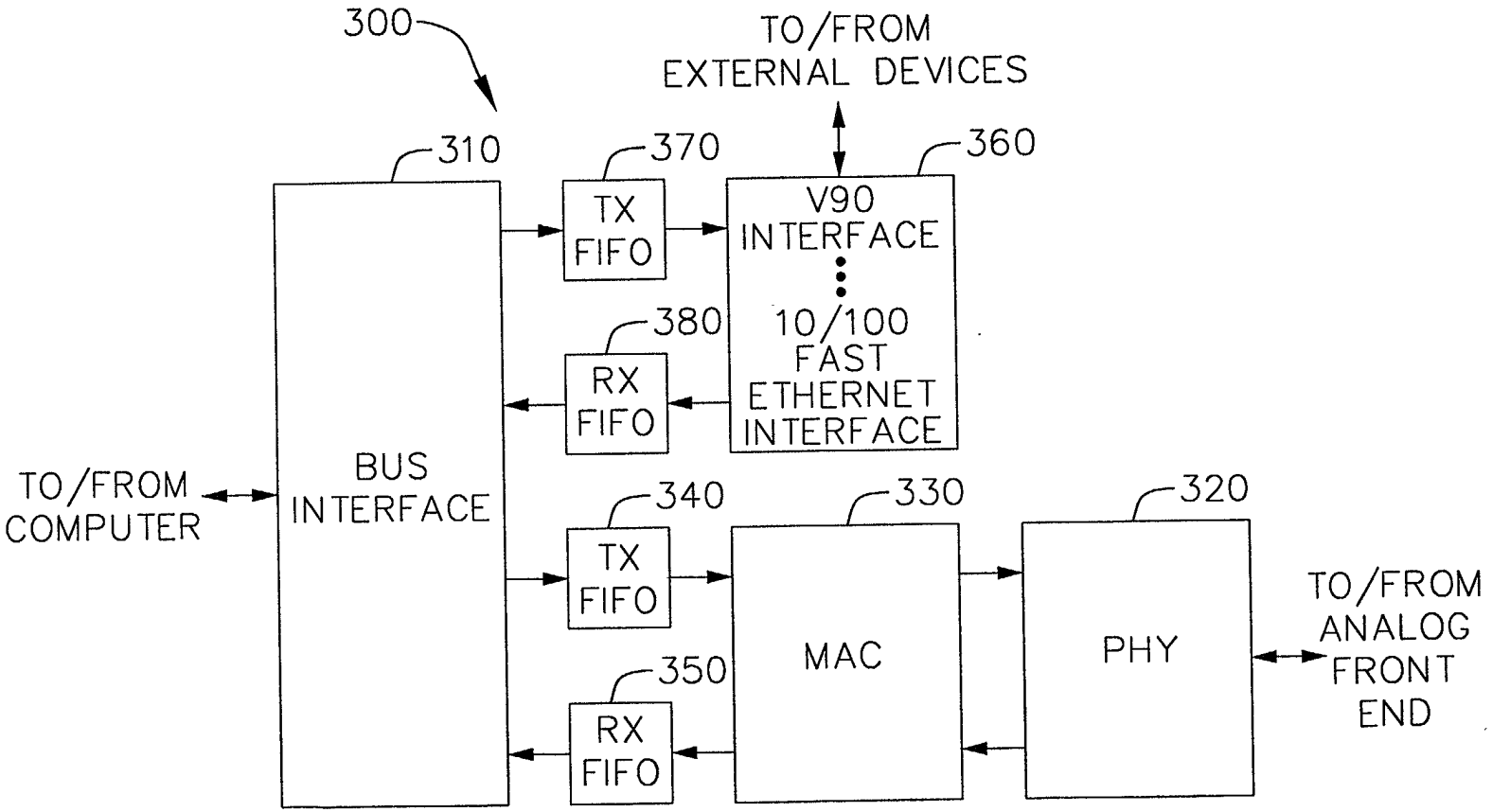

300
TO/FROM
EXTERNAL DEVICES
310
370
360
TX
FIFO
V90
INTERFACE
10/100
FAST
ETHERNET
INTERFACE
380
RX
FIFO
TO/FROM
COMPUTER
BUS
INTERFACE
340
330
320
TX
FIFO
MAC
PHY
TO/FROM
ANALOG
FRONT
END
350
RX
FIFO

*FIG.4b*

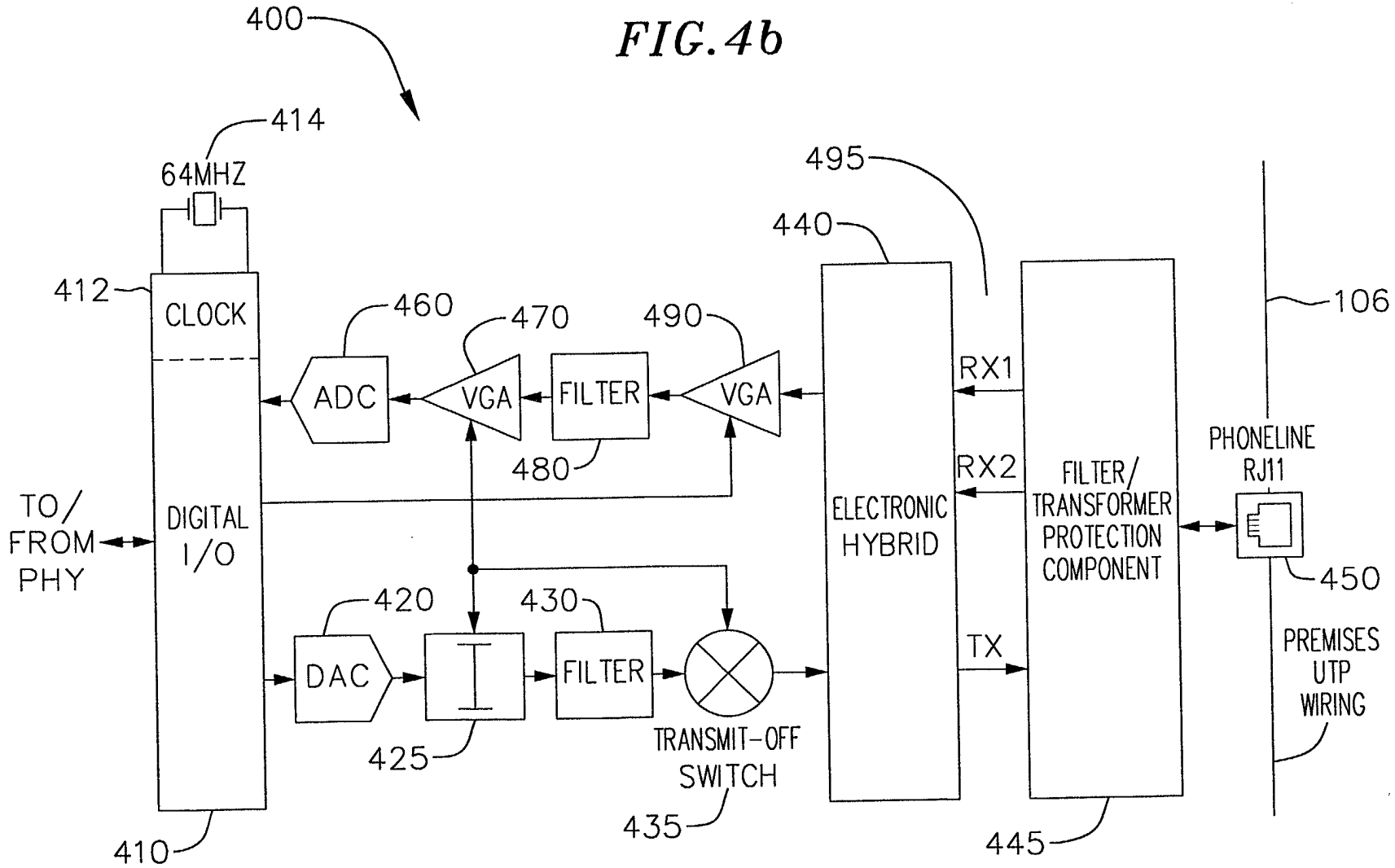

400
414
64MHZ
412
CLOCK
DIGITAL I/O
TO/ FROM PHY
410
460
ADC
470
VGA
FILTER
480
490
VGA
420
DAC
425
430
FILTER
TRANSMIT-OFF SWITCH
435
440
ELECTRONIC HYBRID
495
RX1
RX2
TX
FILTER/ TRANSFORMER PROTECTION COMPONENT
445
106
PHONELINE RJ11
450
PREMISES UTP WIRING

*FIG.5*

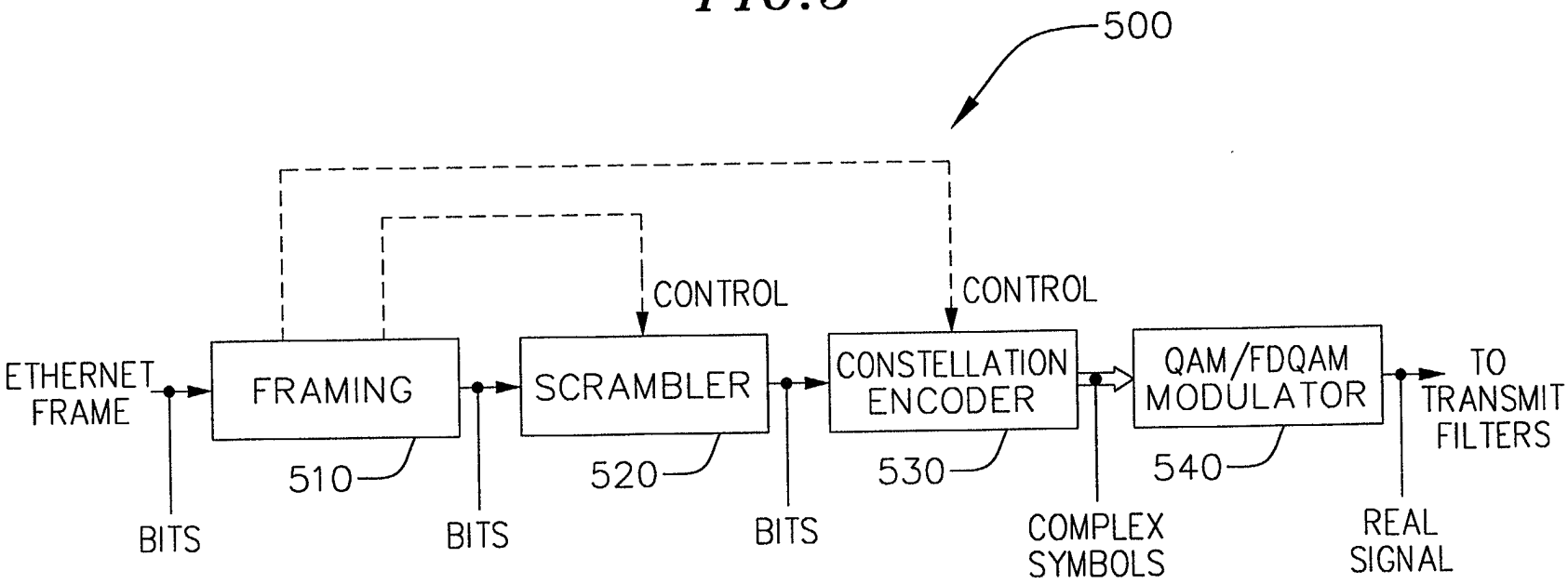

500
CONTROL
CONTROL
ETHERNET FRAME
FRAMING
SCRAMBLER
CONSTELLATION ENCODER
QAM/FDQAM MODULATOR
TO TRANSMIT FILTERS
510
520
530
540
BITS
BITS
BITS
COMPLEX SYMBOLS
REAL SIGNAL

*FIG. 6*

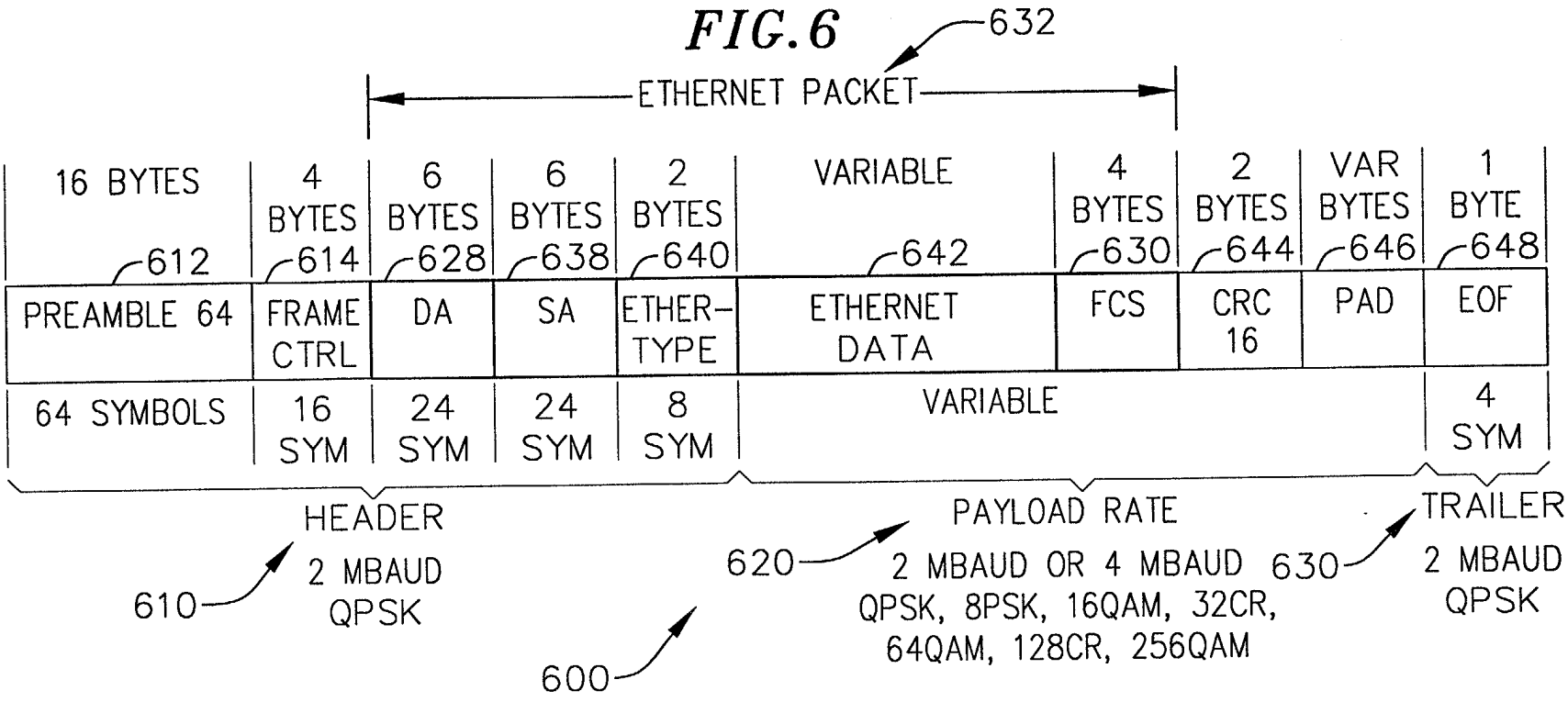

632
ETHERNET PACKET
16 BYTES
612
4 BYTES
614
6 BYTES
628
6 BYTES
638
2 BYTES
640
VARIABLE
642
4 BYTES
630
2 BYTES
644
VAR BYTES
646
1 BYTE
648
PREAMBLE 64
FRAME CTRL
DA
SA
ETHER-TYPE
ETHERNET DATA
FCS
CRC 16
PAD
EOF
64 SYMBOLS
16 SYM
24 SYM
24 SYM
8 SYM
VARIABLE
4 SYM
HEADER
2 MBAUD QPSK
610
PAYLOAD RATE
620
2 MBAUD OR 4 MBAUD
QPSK, 8PSK, 16QAM, 32CR,
64QAM, 128CR, 256QAM
TRAILER
630
2 MBAUD QPSK
600

*FIG. 8*

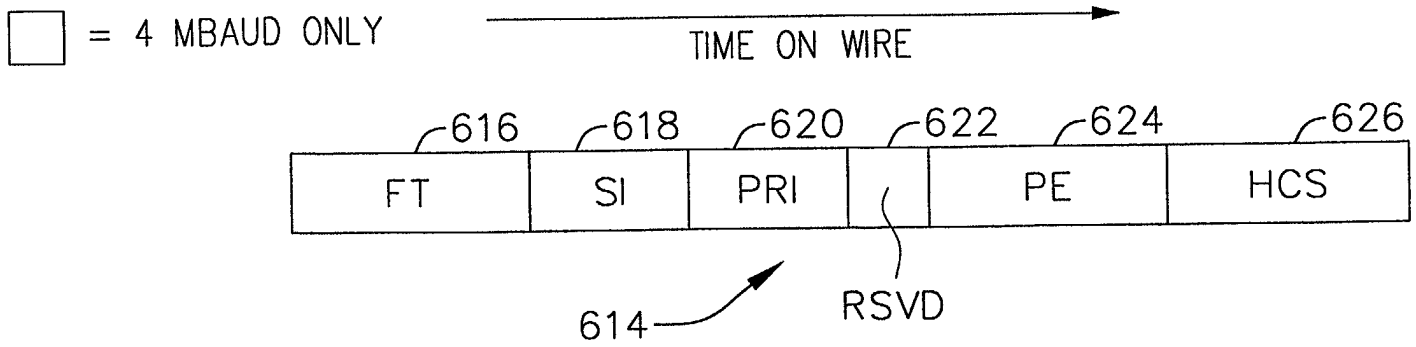

= 4 MBAUD ONLY
TIME ON WIRE
616
618
620
622
624
626
FT
SI
PRI
PE
HCS
614
RSVD

*FIG. 7*

| FIELD | BIT NUMBER | BITS | DESCRIPTION |
|---|---|---|---|
| FT | 31:24 | 8 | FRAME TYPE. THIS FIELD SHALL BE SET TO ZERO BY THE TRANSMITTER. THE RECEIVER SHALL DECODE THIS FIELD AND DISCARD THE FRAME IF IT'S ANYTHING OTHER THAN ZERO. |
| RSVD | 23 | 1 | RESERVED. THIS FIELD SHALL BE SET TO ZERO BY THE TRANSMITTER, AND THE RECEIVER SHALL IGNORE IT. |
| PRI | 22:20 | 3 | PRIORITY (0–7) |
| SI | 19:16 | 4 | SCRAMBLER INITIALIZATION |
| PE | 15:8 | 8 | PAYLOAD ENCODING |
| HCS | 7:0 | 8 | HEADER CHECK SEQUENCE |

*FIG. 9*

| VALUE | INTERPRETATION |
|---|---|
| 0 | RESERVED ON TRANSMIT, DISCARD FRAME ON RECEIVE |
| 1 | BAUD RATE=2 MHz, 2 BITS PER BAUD |
| 2 | BAUD RATE=2 MHz, 3 BITS PER BAUD |
| 3 | BAUD RATE=2 MHz, 4 BITS PER BAUD |
| 4 | BAUD RATE=2 MHz, 5 BITS PER BAUD |
| 5 | BAUD RATE=2 MHz, 6 BITS PER BAUD |
| 6 | BAUD RATE=2 MHz, 7 BITS PER BAUD |
| 7 | BAUD RATE=2 MHz, 8 BITS PER BAUD |
| 8 | RESERVED ON TRANSMIT, DISCARD FRAME ON RECEIVE |
| 9 | BAUD RATE=4 MHz, 2 BITS PER BAUD |
| 10 | BAUD RATE=4 MHz, 3 BITS PER BAUD |
| 11 | BAUD RATE=4 MHz, 4 BITS PER BAUD |
| 12 | BAUD RATE=4 MHz, 5 BITS PER BAUD |
| 13 | BAUD RATE=4 MHz, 6 BITS PER BAUD |
| 14 | BAUD RATE=4 MHz, 7 BITS PER BAUD |
| 15 | BAUD RATE=4 MHz, 8 BITS PER BAUD |
| 16–256 | RESERVED ON TRANSMIT, DISCARD FRAME ON RECEIVE |

EP 0 817 428 A2

FIG. 10

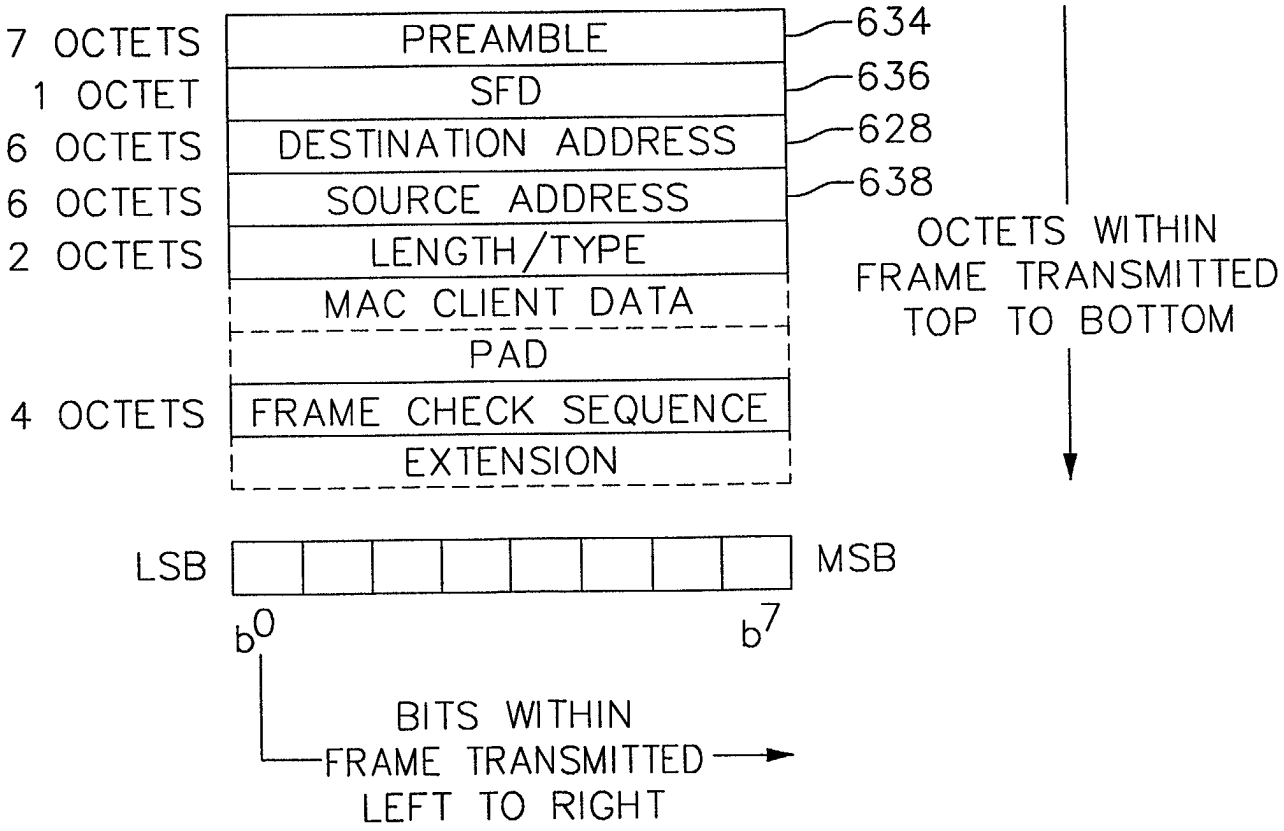
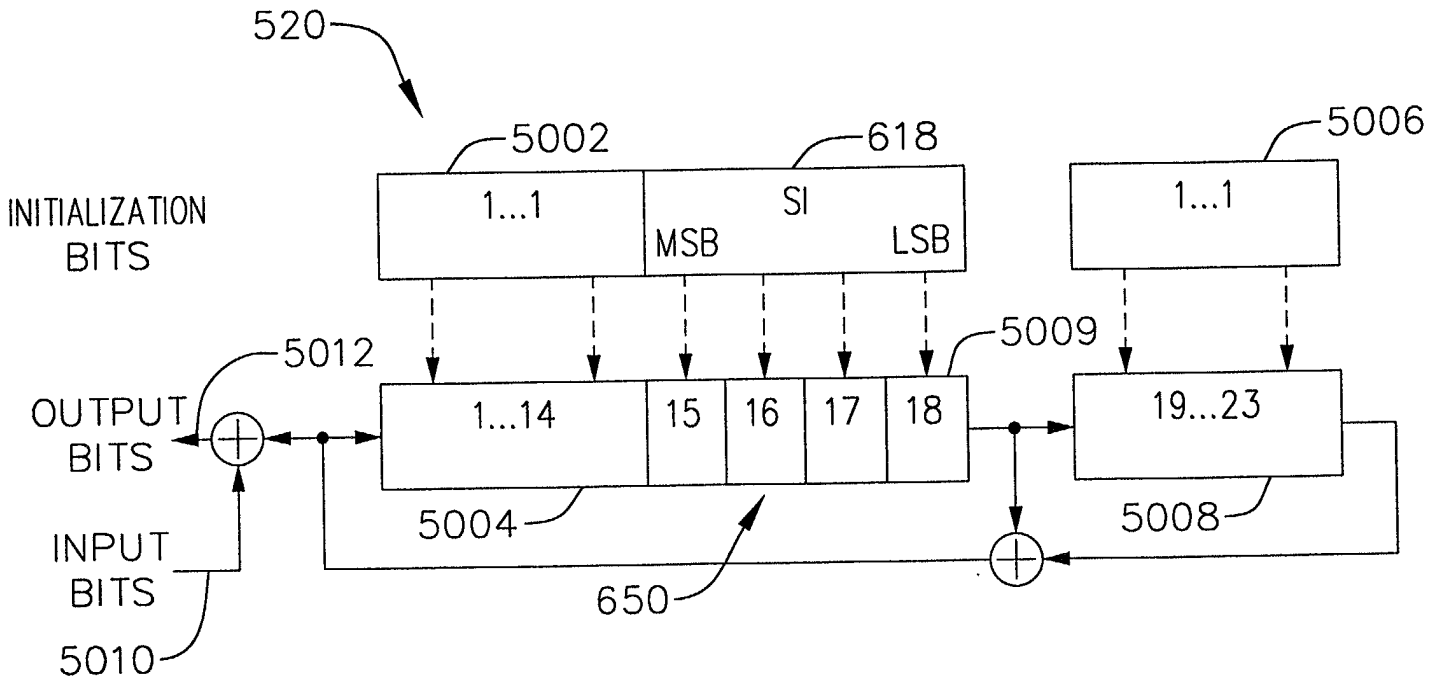


*FIG. 11*


520
5002
618
5006
INITIALIZATION BITS
1...1
SI
MSB
LSB
1...1
5012
5009
OUTPUT BITS
1...14
15
16
17
18
19...23
5004
5008
INPUT BITS
650
5010

EP 0 756 397 A2

*FIG. 12a*

2 BITS PER BAUD

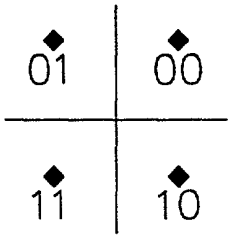



*FIG. 12b*

3 BITS PER BAUD

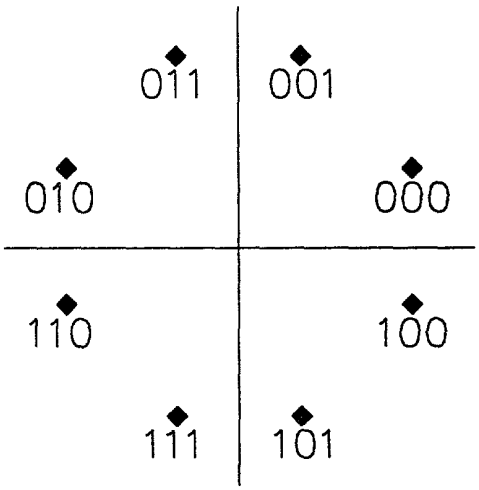



*FIG. 12c*

4 BITS PER BAUD

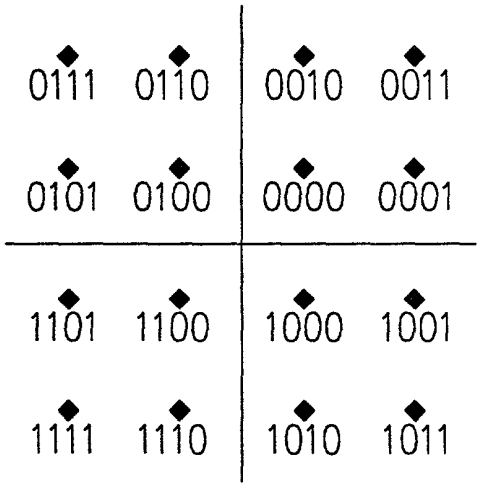
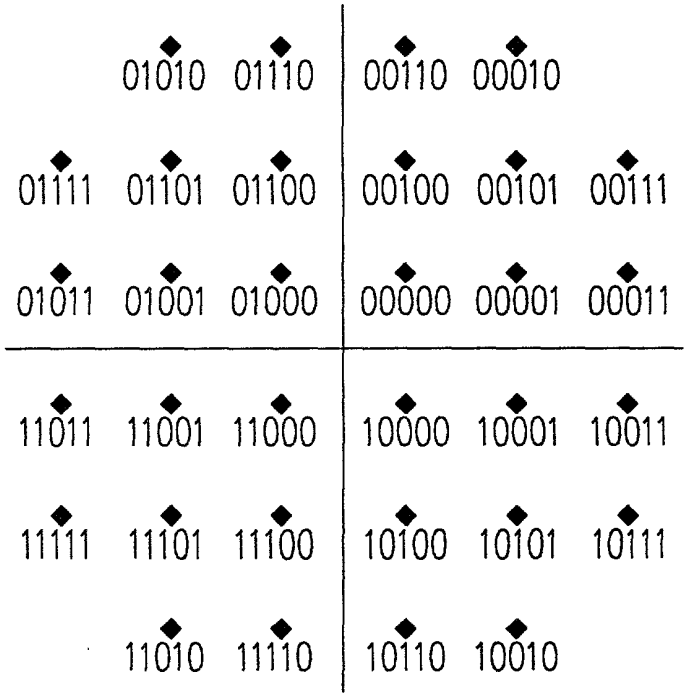



*FIG. 12d*

5 BITS PER BAUD



# FIG. 12e

6 BITS PER BAUD

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 011010 | 011011 | 011001 | 011000 | 001000 | 001001 | 001011 | 001010 |
| 011110 | 011111 | 011101 | 011100 | 001100 | 001101 | 001111 | 001110 |
| 010110 | 010111 | 010101 | 010100 | 000100 | 000101 | 000111 | 000110 |
| 010010 | 010011 | 010001 | 010000 | 000000 | 000001 | 000011 | 000010 |
| 110010 | 110011 | 110001 | 110000 | 100000 | 100001 | 100011 | 100010 |
| 110110 | 110111 | 110101 | 110100 | 100100 | 100101 | 100111 | 100110 |
| 111110 | 111111 | 111101 | 111100 | 101100 | 101101 | 101111 | 101110 |
| 111010 | 111011 | 111001 | 111000 | 101000 | 101001 | 101011 | 101010 |

*FIG. 12f*

7 BITS PER BAUD

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0101100 | 0101101 | 0111101 | 0111100 | 0011100 | 0011101 | 0001101 | 0001100 | | | |
| | | | 0100100 | 0100101 | 0110101 | 0110100 | 0010100 | 0010101 | 0000101 | 0000100 | | | |
| 0110111 | 0110110 | 0110010 | 0110011 | 0110001 | 0110000 | 0010000 | 0010001 | 0010011 | 0010010 | 0010110 | 0010111 | | |
| 0111111 | 0111110 | 0111010 | 0111011 | 0111001 | 0111000 | 0011000 | 0011001 | 0011011 | 0011010 | 0011110 | 0011111 | | |
| 0101111 | 0101110 | 0101010 | 0101011 | 0101001 | 0101000 | 0001000 | 0001001 | 0001011 | 0001010 | 0001110 | 0001111 | | |
| 0100111 | 0100110 | 0100010 | 0100011 | 0100001 | 0100000 | 0000000 | 0000001 | 0000011 | 0000010 | 0000110 | 0000111 | | |
| 1100111 | 1100110 | 1100010 | 1100011 | 1100001 | 1100000 | 1000000 | 1000001 | 1000011 | 1000010 | 1000110 | 1000111 | | |
| 1101111 | 1101110 | 1101010 | 1101011 | 1101001 | 1101000 | 1001000 | 1001001 | 1001011 | 1001010 | 1001110 | 1001111 | | |
| 1111111 | 1111110 | 1111010 | 1111011 | 1111001 | 1111000 | 1011000 | 1011001 | 1011011 | 1011010 | 1011110 | 1011111 | | |
| 1110111 | 1110110 | 1110010 | 1110011 | 1110001 | 1110000 | 1010000 | 1010001 | 1010011 | 1010010 | 1010110 | 1010111 | | |
| | | | 1100100 | 1100101 | 1110101 | 1110100 | 1010100 | 1010101 | 1000101 | 1000100 | | | |
| | | | 1101100 | 1101101 | 1111101 | 1111100 | 1011100 | 1011101 | 1001101 | 1001100 | | | |

# FIG. 12g

8 BITS PER BAUD

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 01100100 | 01100101 | 01100111 | 01100110 | 01100010 | 01100011 | 01100001 | 01100000 |
| 01101100 | 01101101 | 01101111 | 01101110 | 01101010 | 01101011 | 01101001 | 01101000 |
| 01111100 | 01111101 | 01111111 | 01111110 | 01111010 | 01111011 | 01111001 | 01111000 |
| 01110100 | 01110101 | 01110111 | 01110110 | 01110010 | 01110011 | 01110001 | 01110000 |
| 01010100 | 01010101 | 01010111 | 01010110 | 01010010 | 01010011 | 01010001 | 01010000 |
| 01011100 | 01011101 | 01011111 | 01011110 | 01011010 | 01011011 | 01011001 | 01011000 |
| 01001100 | 01001101 | 01001111 | 01001110 | 01001010 | 01001011 | 01001001 | 01001000 |
| 01000100 | 01000101 | 01000110 | 01000110 | 01000010 | 01000011 | 01000001 | 01000000 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 00100000 | 00100001 | 00100011 | 00100010 | 00100110 | 00100111 | 00100101 | 00100100 |
| 00101000 | 00101001 | 00101011 | 00101010 | 00101110 | 00101111 | 00101101 | 0010110 |
| 00111000 | 00111001 | 00111011 | 00111010 | 00111110 | 00111111 | 00111101 | 00111100 |
| 00110000 | 00110001 | 00110011 | 00110010 | 00110110 | 00110111 | 00110101 | 00110100 |
| 00010000 | 00010001 | 00010011 | 00010010 | 00010110 | 00010111 | 00010101 | 00010100 |
| 00011000 | 00011001 | 00011011 | 00011010 | 00011110 | 00011111 | 00011101 | 00011100 |
| 00001000 | 00001001 | 00001011 | 00001010 | 00001110 | 00001111 | 00001101 | 00001100 |
| 00000000 | 00000001 | 00000011 | 00000010 | 00000110 | 00000111 | 00001101 | 00000100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11000100 | 11000101 | 11000111 | 11000110 | 11000010 | 11000011 | 11000001 | 11000000 |
| 11001100 | 11001101 | 11001111 | 11001110 | 11001010 | 11001011 | 11001001 | 11001000 |
| 11011100 | 11011101 | 11011111 | 11011110 | 11011010 | 11011011 | 11011001 | 11011000 |
| 11010100 | 11010101 | 11010111 | 11010110 | 11010010 | 11010011 | 11010001 | 11010000 |
| 11110100 | 11110101 | 11110111 | 11110110 | 11110010 | 11110011 | 11110001 | 11110000 |
| 11111100 | 11111101 | 11111111 | 11111110 | 11111010 | 11111011 | 11111001 | 11111000 |
| 11101100 | 11101101 | 11101111 | 11101110 | 11101010 | 11101011 | 11101001 | 11101000 |
| 11100100 | 11100101 | 11100111 | 11100110 | 11100010 | 11100011 | 11100001 | 11100000 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10000000 | 10000001 | 10000011 | 10000010 | 10000110 | 10000111 | 10000101 | 10000100 |
| 10001000 | 10001001 | 10001011 | 10001010 | 10001110 | 10001111 | 10001101 | 10001100 |
| 10011000 | 10011001 | 10011011 | 10011010 | 10011110 | 10011111 | 10011101 | 10011100 |
| 10010000 | 10010001 | 10010011 | 10010010 | 10010110 | 10010111 | 10010101 | 10010100 |
| 10110000 | 10110001 | 10110011 | 10110010 | 10110110 | 10110111 | 10110101 | 10110100 |
| 10111000 | 10111001 | 10111011 | 10111010 | 10111110 | 10111111 | 10111101 | 10111100 |
| 10101000 | 10101001 | 10101011 | 10101010 | 10101110 | 10101111 | 10101101 | 10101100 |
| 10100000 | 10100001 | 10100011 | 10100010 | 10100110 | 10100111 | 10100101 | 10100100 |

*FIG. 13*

| BITS PER BAUD | REFERENCE POINT(S) | VALUE |
|---|---|---|
| 2 | 00 | 1+i |
| 3 | 000<br>001 | (12+5i)/9<br>(5+12i)/9 |
| 4 | 0000 | (1+i)/3 |
| 5 | 00000 | (1+i)/4 |
| 6 | 000000 | (1+i)/7 |
| 7 | 0000000 | (1+i)/9 |
| 8 | 00000000 | (1+i)/15 |

*FIG. 14*

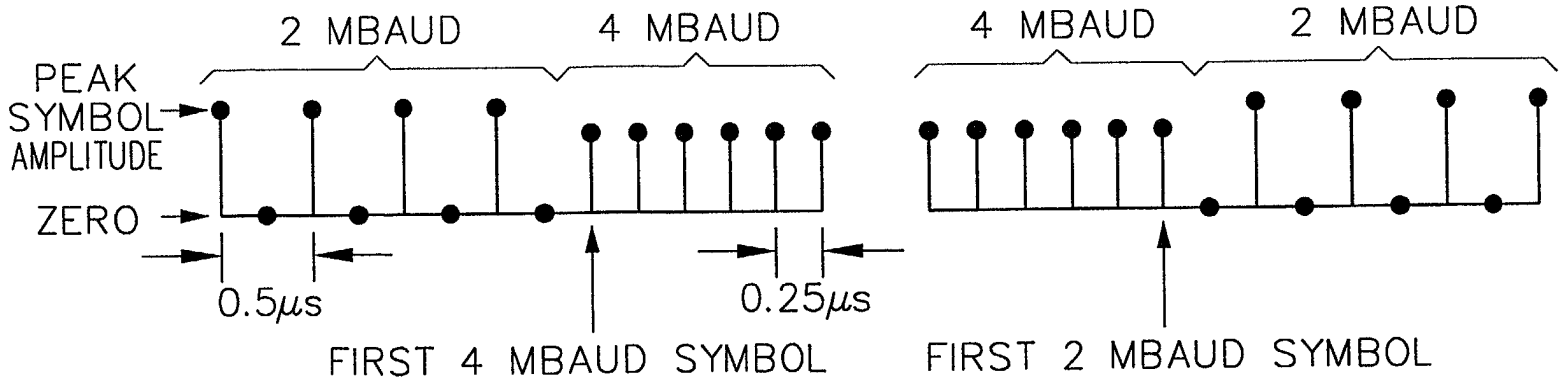


*FIG. 15*

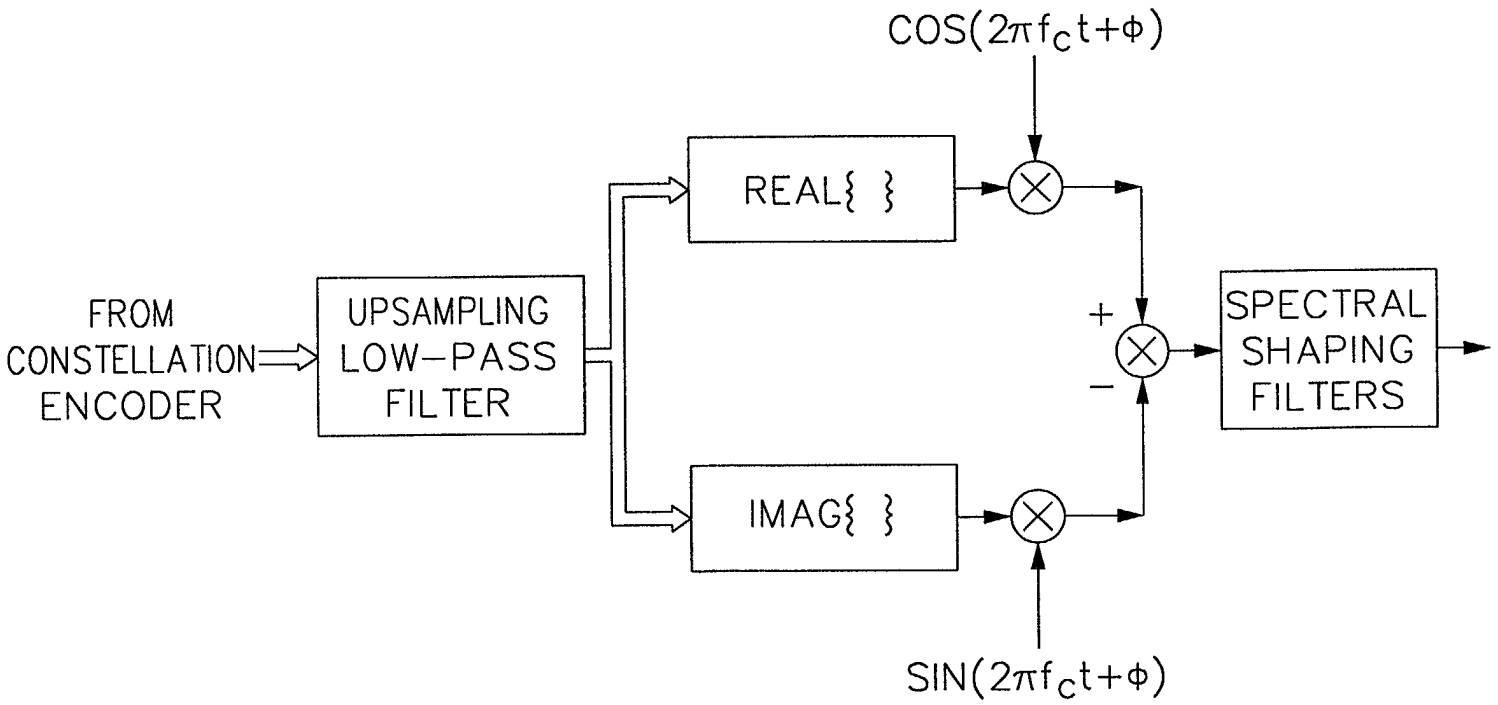

COS(2πf_c t+φ)
REAL{ }
FROM CONSTELLATION ENCODER
UPSAMPLING LOW-PASS FILTER
+
−
SPECTRAL SHAPING FILTERS
IMAG{ }
SIN(2πf_c t+φ)

*FIG. 16*

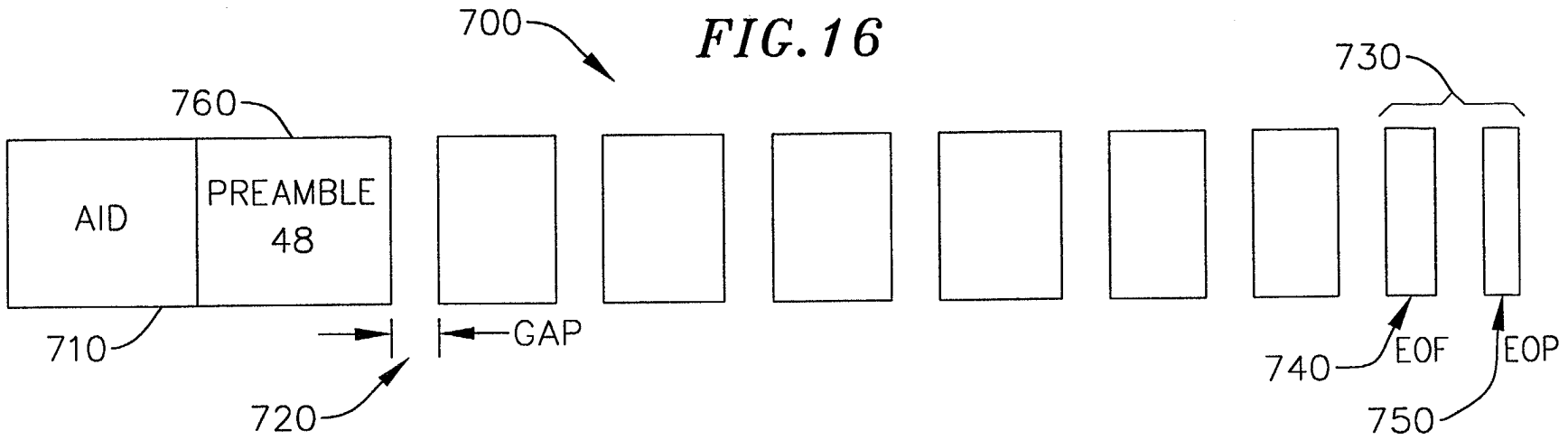

700
760
730
AID
PREAMBLE
48
710
GAP
720
740
EOF
EOP
750

*FIG. 17*

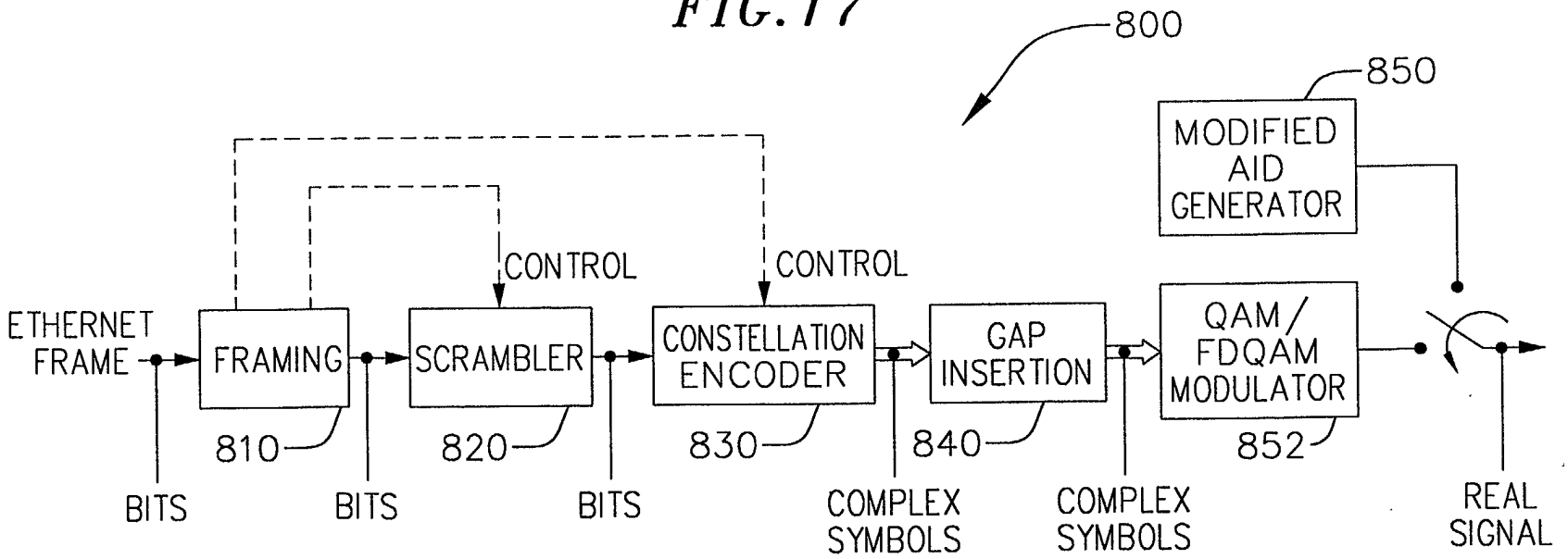

800
850
MODIFIED
AID
GENERATOR
CONTROL
CONTROL
ETHERNET
FRAME
FRAMING
SCRAMBLER
CONSTELLATION
ENCODER
GAP
INSERTION
QAM/
FDQAM
MODULATOR
810
820
830
840
852
BITS
BITS
BITS
COMPLEX
SYMBOLS
COMPLEX
SYMBOLS
REAL
SIGNAL

*FIG. 18*

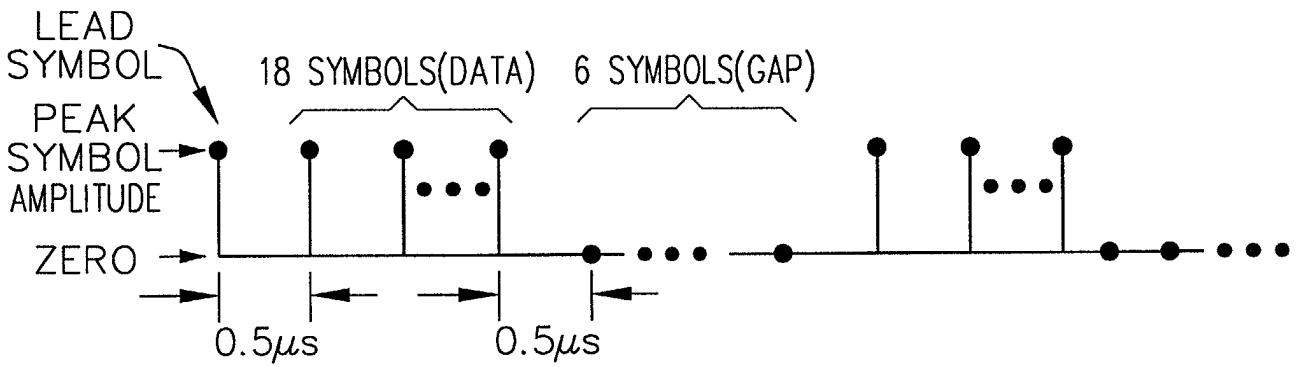

LEAD SYMBOL
18 SYMBOLS(DATA)
6 SYMBOLS(GAP)
PEAK SYMBOL AMPLITUDE
ZERO
0.5μs
0.5μs

*FIG. 19*

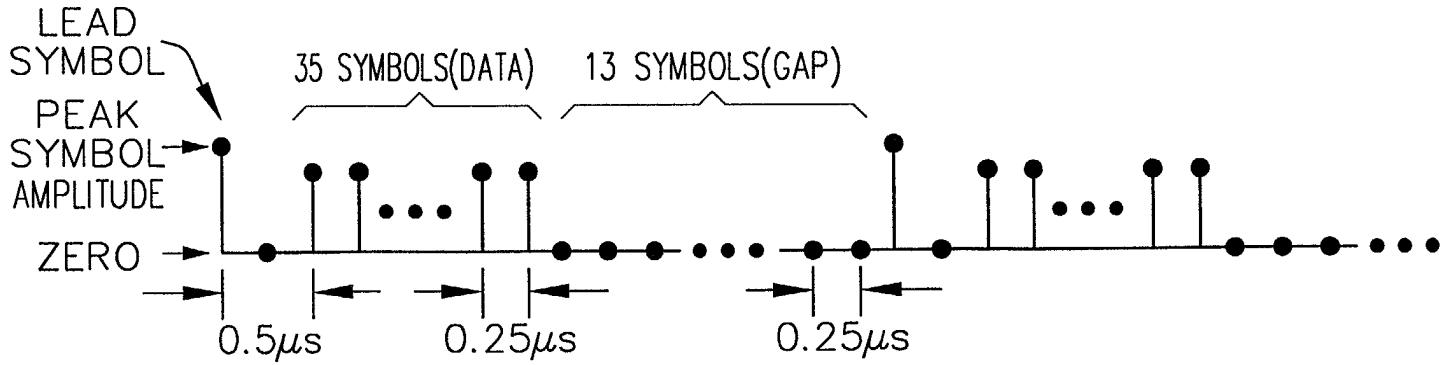

LEAD SYMBOL
35 SYMBOLS(DATA)
13 SYMBOLS(GAP)
PEAK SYMBOL AMPLITUDE
ZERO
0.5μs
0.25μs
0.25μs

*FIG.20*

| M MODULO 2 | P MODULO 2 | EOF/EOP SEQUENCE |
|---|---|---|
| 0 | 0 | • 4 SYMBOLS, DEFINED BY THE BITS 0xfc<br>• 12 ZERO SYMBOLS<br>• 1 SYMBOL, DEFINED BY THE BITS 00 |
| 0 | 1 | • 4 SYMBOLS, DEFINED BY THE BITS 0x03<br>• 12 ZERO SYMBOLS<br>• 1 SYMBOL, DEFINED BY THE BITS 11 |
| 1 | 0 | • 4 SYMBOLS, DEFINED BY THE BITS 0x03<br>• 12 ZERO SYMBOLS<br>• 1 SYMBOL, DEFINED BY THE BITS 11 |
| 1 | 1 | • 4 SYMBOLS, DEFINED BY THE BITS 0xfc<br>• 12 ZERO SYMBOLS<br>• 1 SYMBOL, DEFINED BY THE BITS 00 |

*FIG.21*

| M MODULO 2 | P MODULO 4 | EOF/EOP SEQUENCE |
|---|---|---|
| 0 | 0 | •4 SYMBOLS, DEFINED BY THE BITS 0xfc<br>•12 ZERO SYMBOLS<br>•1 SYMBOL, DEFINED BY THE BITS 00 |
| 0 | 1 | •4 SYMBOLS, DEFINED BY THE BITS 0x56<br>•12 ZERO SYMBOLS<br>•1 SYMBOL, DEFINED BY THE BITS 10 |
| 0 | 2 | •4 SYMBOLS, DEFINED BY THE BITS 0x03<br>•12 ZERO SYMBOLS<br>•1 SYMBOL, DEFINED BY THE BITS 11 |
| 0 | 3 | •4 SYMBOLS, DEFINED BY THE BITS 0xa9<br>•12 ZERO SYMBOLS<br>•1 SYMBOL, DEFINED BY THE BITS 01 |
| 1 | 0 | •4 SYMBOLS, DEFINED BY THE BITS 0x03<br>•12 ZERO SYMBOLS<br>•1 SYMBOL, DEFINED BY THE BITS 11 |
| 1 | 1 | •4 SYMBOLS, DEFINED BY THE BITS 0xa9<br>•12 ZERO SYMBOLS<br>•1 SYMBOL, DEFINED BY THE BITS 01 |
| 1 | 2 | •4 SYMBOLS, DEFINED BY THE BITS 0xfc<br>•12 ZERO SYMBOLS<br>•1 SYMBOL, DEFINED BY THE BITS 00 |
| 1 | 3 | •4 SYMBOLS, DEFINED BY THE BITS 0x56<br>•12 ZERO SYMBOLS<br>•1 SYMBOL, DEFINED BY THE BITS 10 |

FIG.22

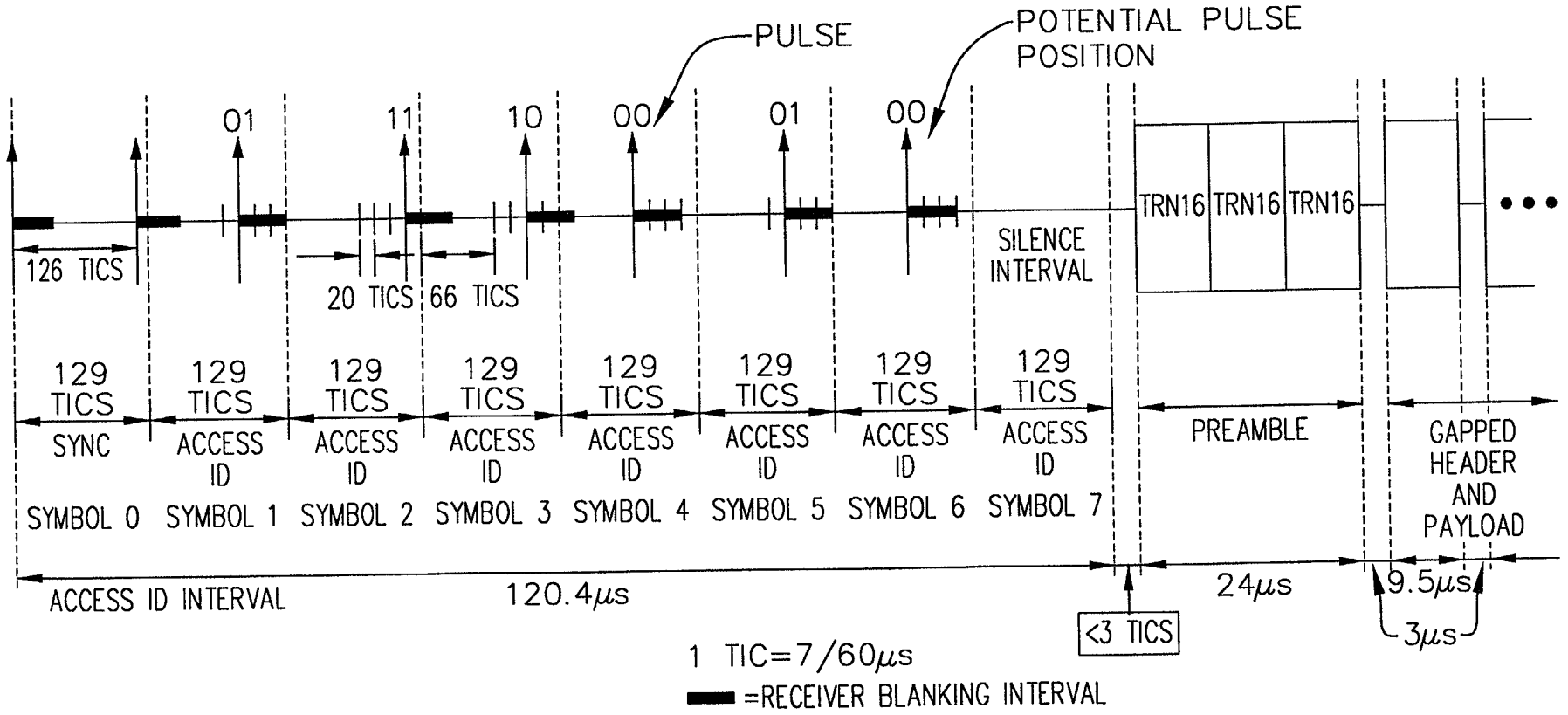

PULSE
POTENTIAL PULSE POSITION
01
11
10
00
01
00
TRN16 TRN16 TRN16
126 TICS
20 TICS
66 TICS
SILENCE INTERVAL
129 TICS
SYNC
ACCESS ID
SYMBOL 0
SYMBOL 1
SYMBOL 2
SYMBOL 3
SYMBOL 4
SYMBOL 5
SYMBOL 6
SYMBOL 7
PREAMBLE
GAPPED HEADER AND PAYLOAD
ACCESS ID INTERVAL
120.4μs
24μs
9.5μs
3μs
<3 TICS
1 TIC=7/60μs
=RECEIVER BLANKING INTERVAL

FIG.23a

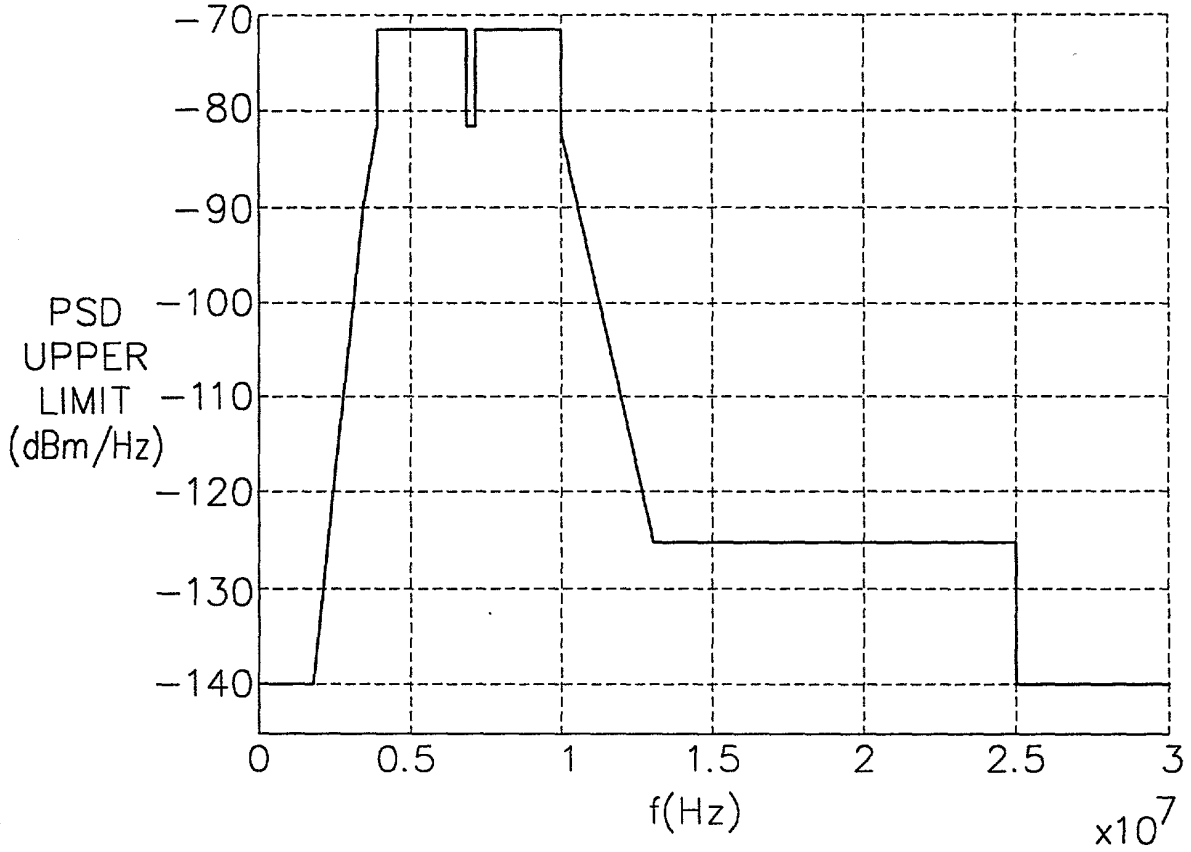



FIG.23b

| FREQUENCY(MHz) | PSD LIMIT(dBm/Hz) |
|---|---|
| 0.015<f<=1.7 | -140 |
| 1.7<f<=3.5 | -140+(f-1.7)*50.0/1.8 |
| 3.5<f<=4.0 | -90+(f-3.5)*17.0 |
| 4.0<f<=7.0 | -71.5 |
| 7.0<f<=7.3 | -81.5 |
| 7.3<f<=10.0 | -71.5 |
| 10.0<f<=13.0 | -81.5-(f-10.0)*43.5/3.0 |
| 13.0<f<=25.0 | -125 |
| 25.0<f<=30.0 | -140 |

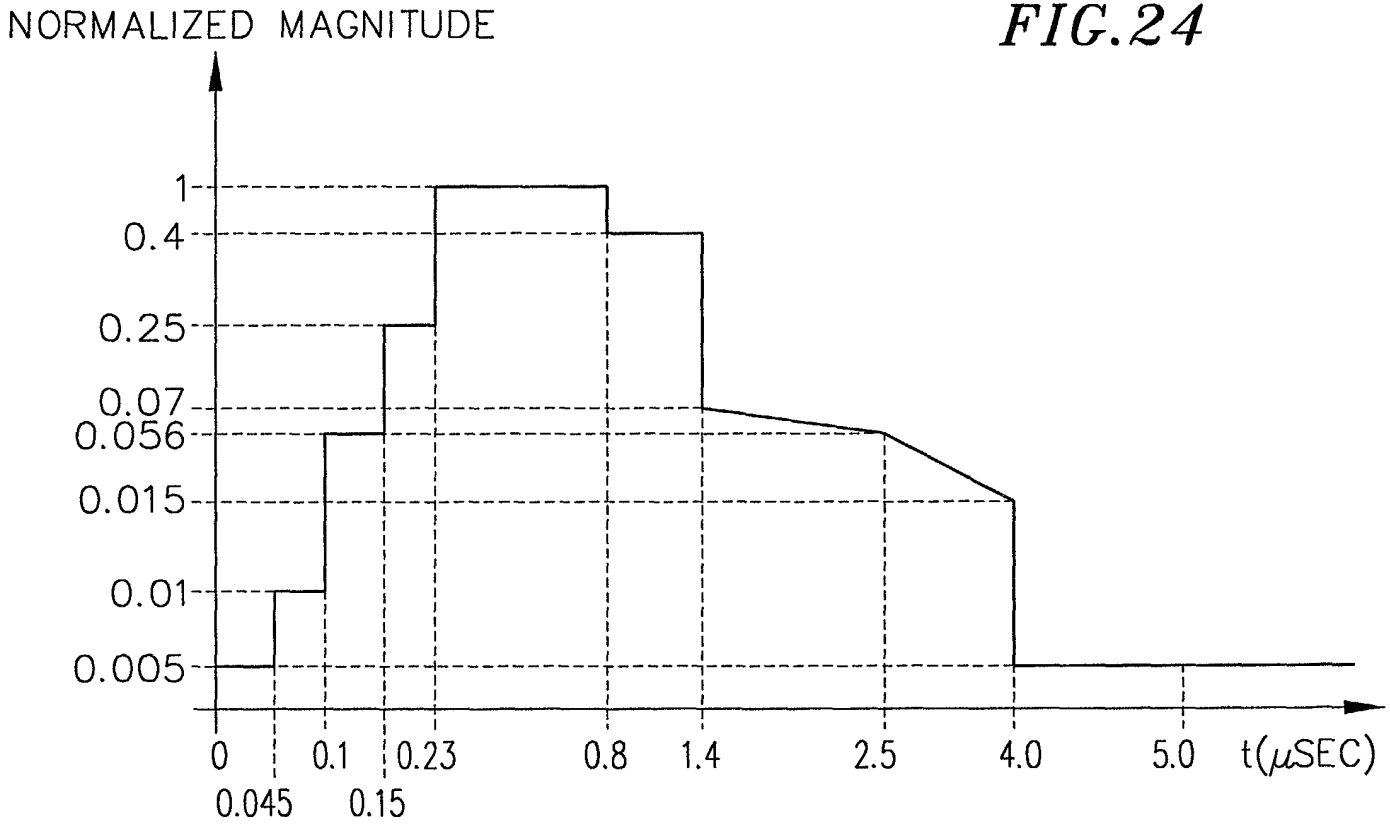

NORMALIZED MAGNITUDE
1
0.4
0.25
0.07
0.056
0.015
0.01
0.005
0
0.045
0.1
0.15
0.23
0.8
1.4
2.5
4.0
5.0
t(μSEC)

*FIG.24*

*FIG.25*

| FREQUENCY RANGE(MHz) | MAXIMUM PEAK-TO-PEAKINTERFERER LEVEL(VOLTS) |
|---|---|
| 0.01-0.1 | 6.0 |
| 0.1-0.6 | 3.3 |
| 0.6-1.7 | 1.0 |
| 1.7-4.0 | 0.1 |
| 7.0-7.3 | 0.1 |
| 10.0-10.15 | 0.1 |
| 14.0-14.35 | 0.28 |
| 18.068-18.168 | 0.5 |
| 21.0-21.45 | 0.5 |
| 24.89-24.99 | 0.5 |
| 28.0-29.7 | 0.5 |

*FIG.26*

| FREQUENCY RANGE(MHz) | MAXIMUM PEAK-TO-PEAKINTERFERER LEVEL(VOLTS) |
|---|---|
| 0.01-0.1 | 20.0 |
| 0.1-0.6 | 20.0 |
| 0.6-1.7 | 10.0 |
| 1.7-4.0 | 2.5 |
| 7.0-7.3 | 2.5 |
| 10.0-10.15 | 2.5 |
| 14.0-14.35 | 5.0 |
| 18.068-18.168 | 5.0 |
| 21.0-21.45 | 5.0 |
| 24.89-24.99 | 5.0 |
| 28.0-29.7 | 5.0 |

*FIG.27*

| FREQUENCY RANGE(kHz) | MIN.IMPEDANCE(OHMS) |
|---|---|
| 0<f<=0.285 | 1 M |
| 0.285<f<=2.85 | 100 k |
| 2.85<f<=28.5 | 10 k |
| 28.5<f<=95 | 4.0 k |
| 95<f<=190 | 2.0 k |
| 190<f<=285 | 1.4 k |
| 285<f<=380 | 1.0 k |
| 380<f<=475 | 850 |
| 475<f<=570 | 700 |
| 570<f<=665 | 600 |
| 665<f<=760 | 525 |
| 760<f<=855 | 450 |
| 855<f<=950 | 400 |
| 950<f<=1000 | 350 |
| 1000<f<=1400 | 175 |
| 1400<f<=2300 | 100 |
| 2300<f<=2850 | 50 |
| 2850<f<=3085 | 25 |
| 3085<f<=3725 | 10 |
| 3725<f<=3935 | 25 |
| 3935<f<=4000 | 50 |
| 10000<f<=10450 | 40 |
| 10450<f<=10925 | 25 |
| 10925<f<=13125 | 10 |
| 13125<f<=14175 | 25 |
| 14175<f<=16800 | 50 |
| 16800<f<=21000 | 100 |
| 21000<f<=30000 | 50 |

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*FIG.28*

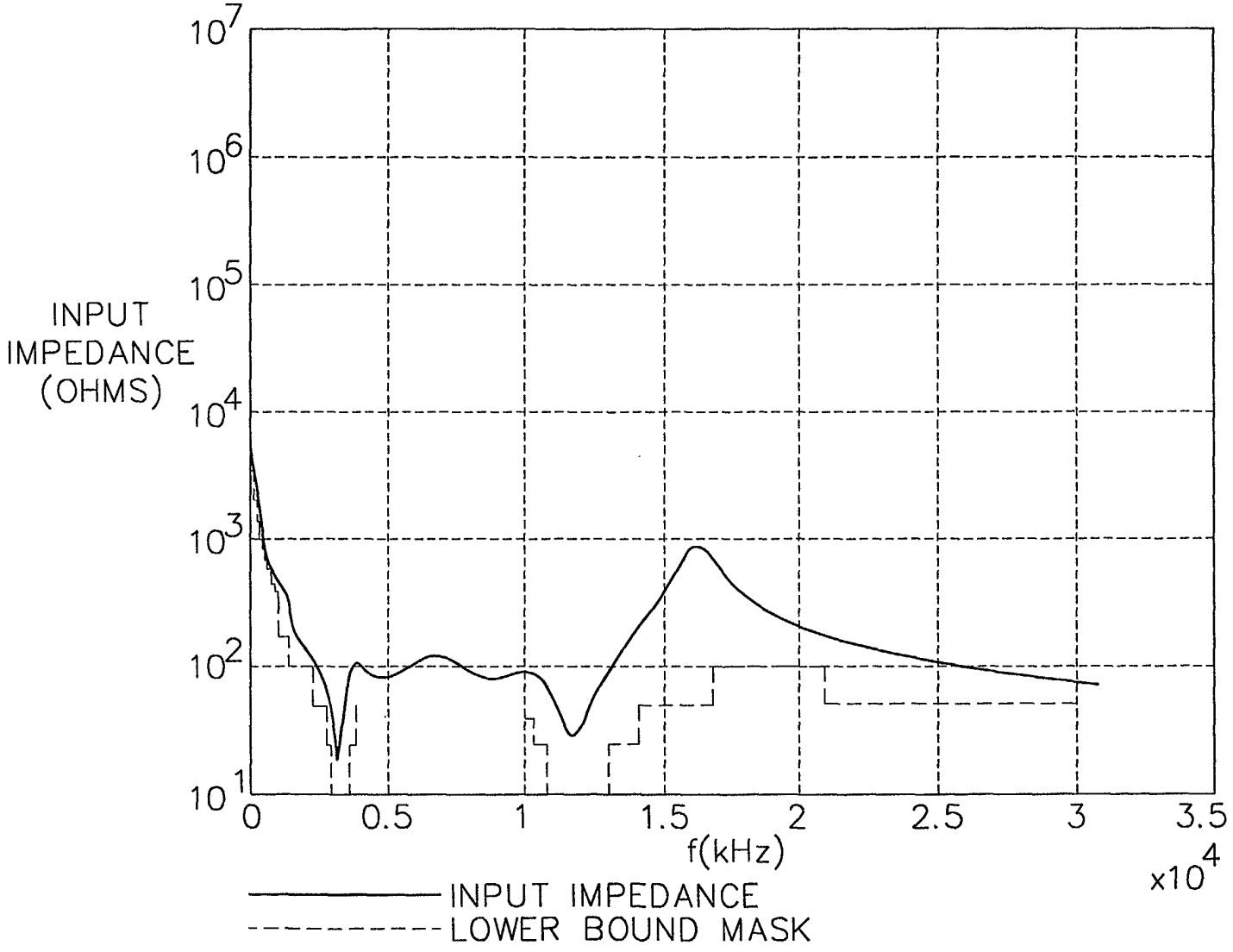
INPUT IMPEDANCE (OHMS)
$10^7$
$10^6$
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
0
0.5
1
1.5
2
2.5
3
3.5
f(kHz)
x$10^4$
INPUT IMPEDANCE
LOWER BOUND MASK

*FIG.29*

| OSI | IEEE | FUNCTION |
|---|---|---|
| DATA LINK | – | LINK LAYER SIGNALING(DRIVER)<br>a) RATE ADAPTATION, QoS AND 1M8 COMPATIBILITY<br>b) LARQ ERROR RECOVERY<br>c) LINK INTEGRITY AND CAPABILITY DISCOVERY |
| | MAC CONTROLLER LAYER | MAC CONTROLLER LAYER FUNCTIONS<br>a) HOST INTERFACE<br>b) CONTROL AND STATUS REGISTERS, INTERRUPTS<br>c) DMA TRANSFERS, DATA BUFFERING AND COMMAND LIST INTERPRETATION<br>d) PERFORMANCE COUNTERS<br>e) MAC ADDRESS FILTERING, WAKE–ON–LAN PROCESSING |
| | MII | OPTIONAL MII INTERFACE (IN PHY–ONLY) |
| | LLC– LOGICAL LINK CONTROL | OPTIONAL LINK LAYER SIGNALING (IN PHY–ONLY)<br>a) RATE ADAPTATION, QoS AND 1M8 COMPATIBILITY<br>b)<br>c) LINK INTEGRITY AND CAPABILITY DISCOVERY |
| | | FRAME PROCESSING (TRANSMIT AND RECEIVE)<br>a) FRAMING (FRAME BOUNDARY DELINEATION AND SYNCHRONIZATION)<br>b) ERROR DETECTION (FCS GENERATION AND CHECK, FRAGMENT DETECTION) |
| | V2 MAC | MEDIA ACCESS CONTROL (MAC)<br>a) CSMA/CD<br>b) COLLISION RESOLUTION (BACKOFF ALGORITHM) |
| PHY | PHY | PHYSICAL CODING SUBLAYER<br>a) CODING AND MODULATION, CARRIER SENSE, COLLISION DETECTION |

*FIG.30*

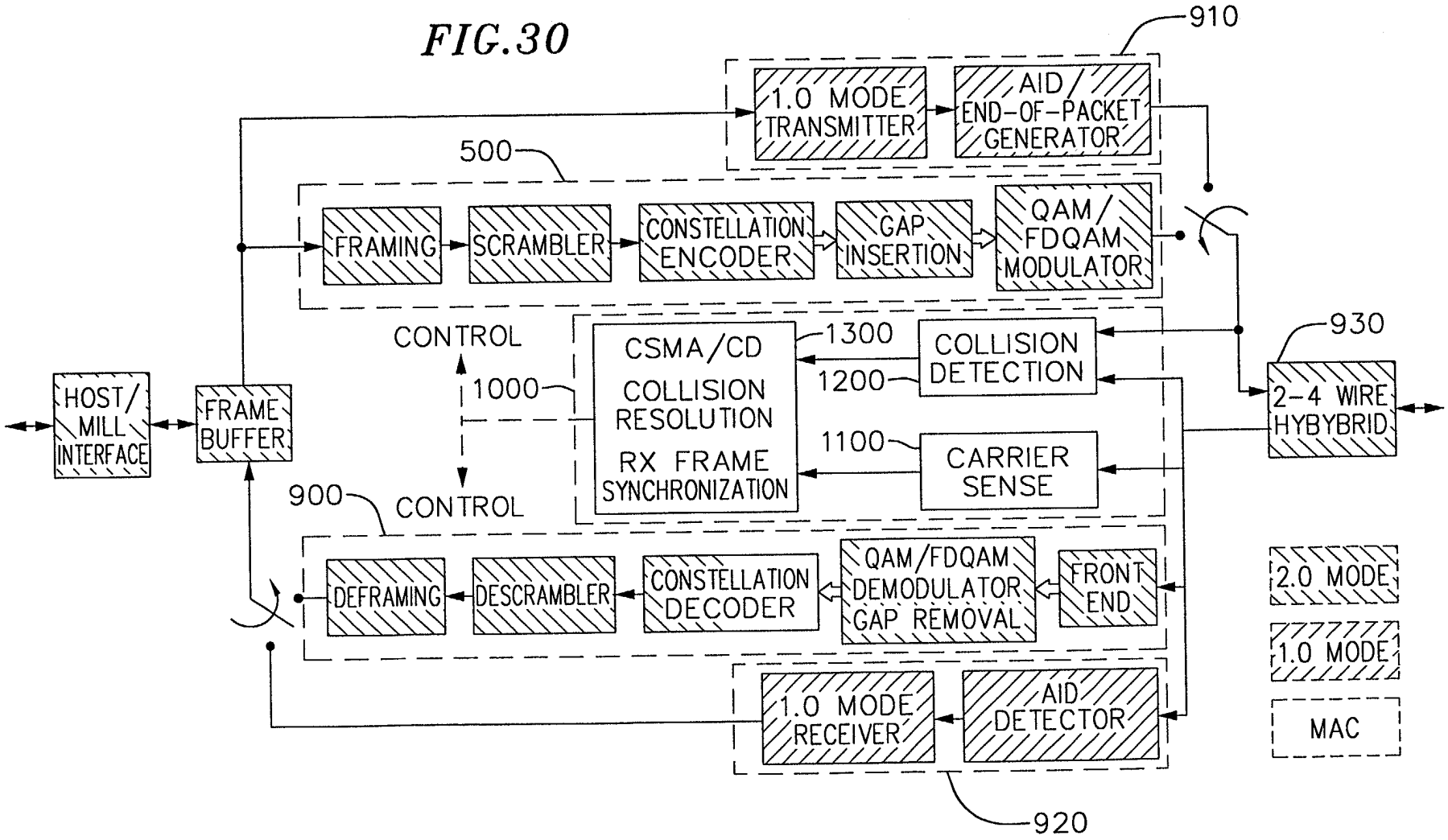
910
1.0 MODE TRANSMITTER
AID/ END-OF-PACKET GENERATOR
500
FRAMING
SCRAMBLER
CONSTELLATION ENCODER
GAP INSERTION
QAM/ FDQAM MODULATOR
CONTROL
1000
CSMA/CD
COLLISION RESOLUTION
RX FRAME SYNCHRONIZATION
1300
COLLISION DETECTION
1200
1100
CARRIER SENSE
930
2-4 WIRE HYBYBRID
HOST/ MILL INTERFACE
FRAME BUFFER
900
CONTROL
DEFRAMING
DESCRAMBLER
CONSTELLATION DECODER
QAM/FDQAM DEMODULATOR GAP REMOVAL
FRONT END
1.0 MODE RECEIVER
AID DETECTOR
920
2.0 MODE
1.0 MODE
MAC

*FIG.31*

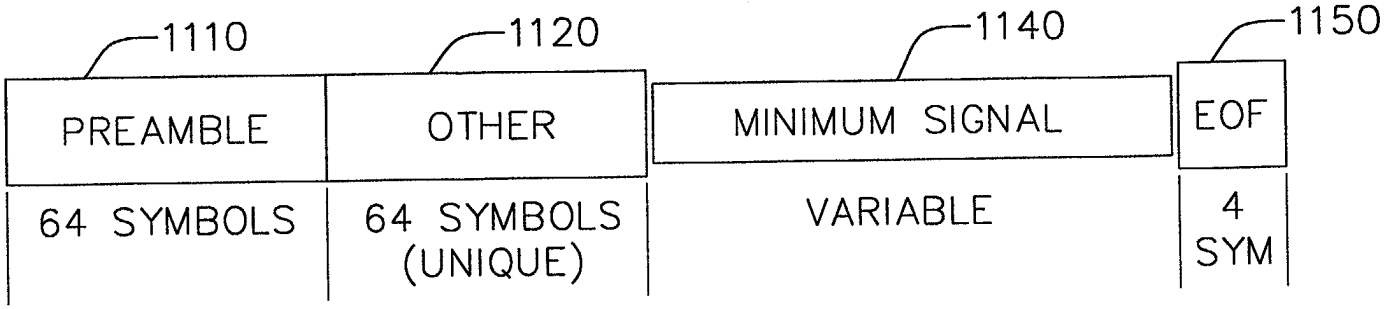


*FIG.32*

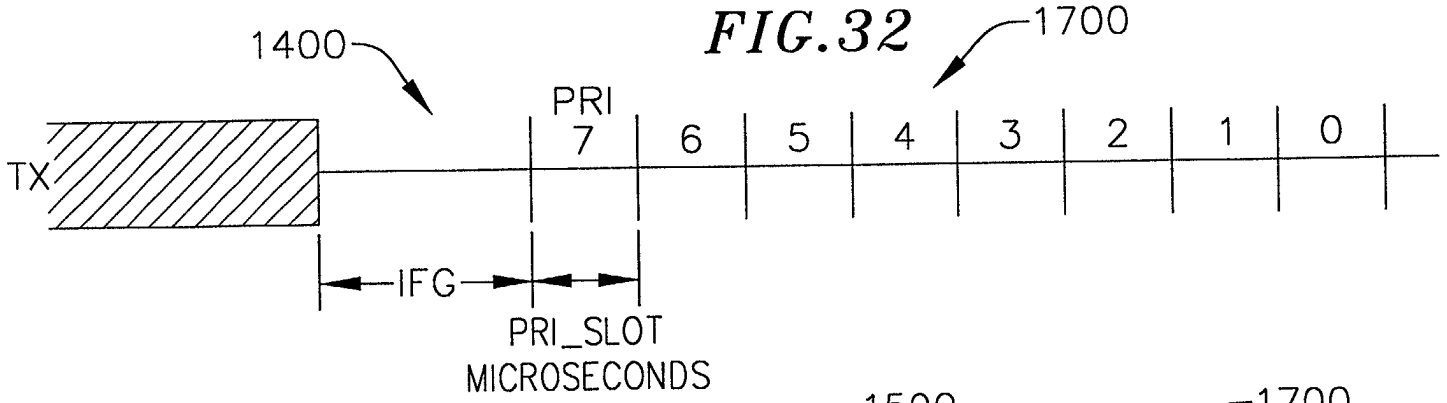


*FIG.33*

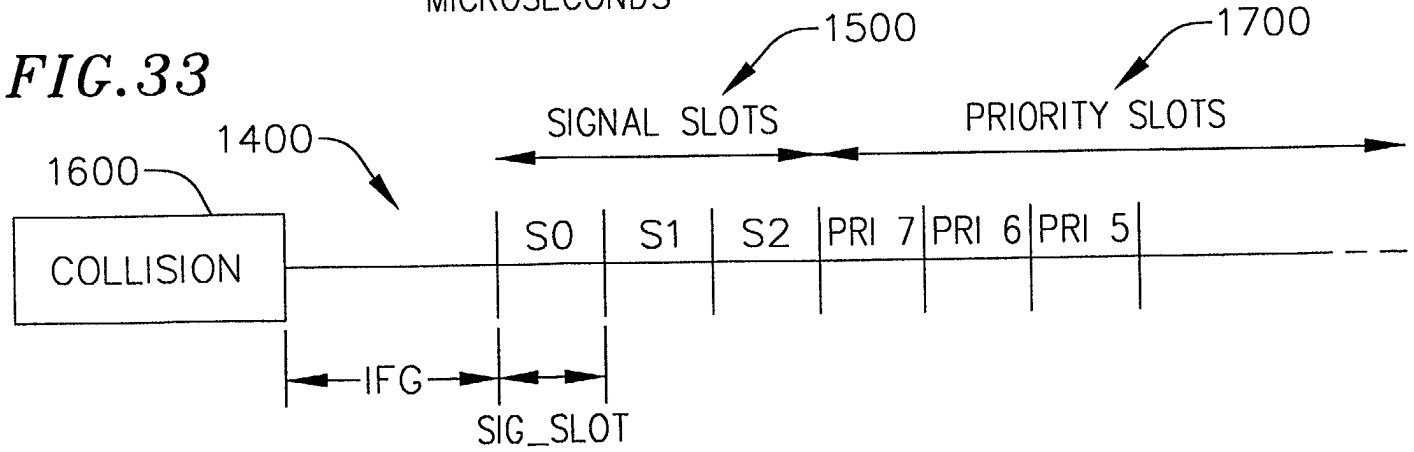

*FIG.34a*

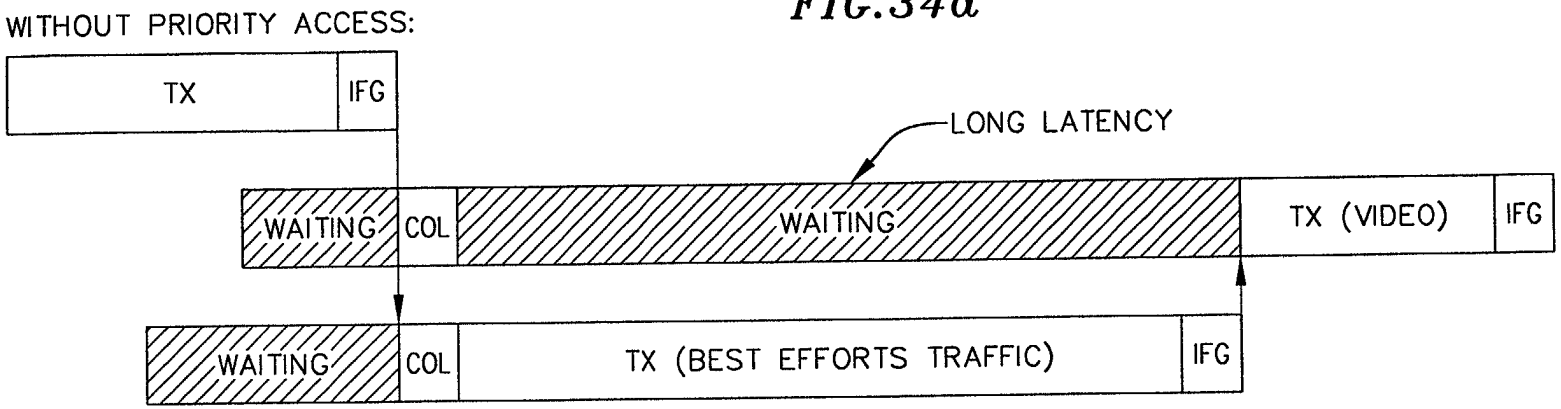


*FIG.34b*

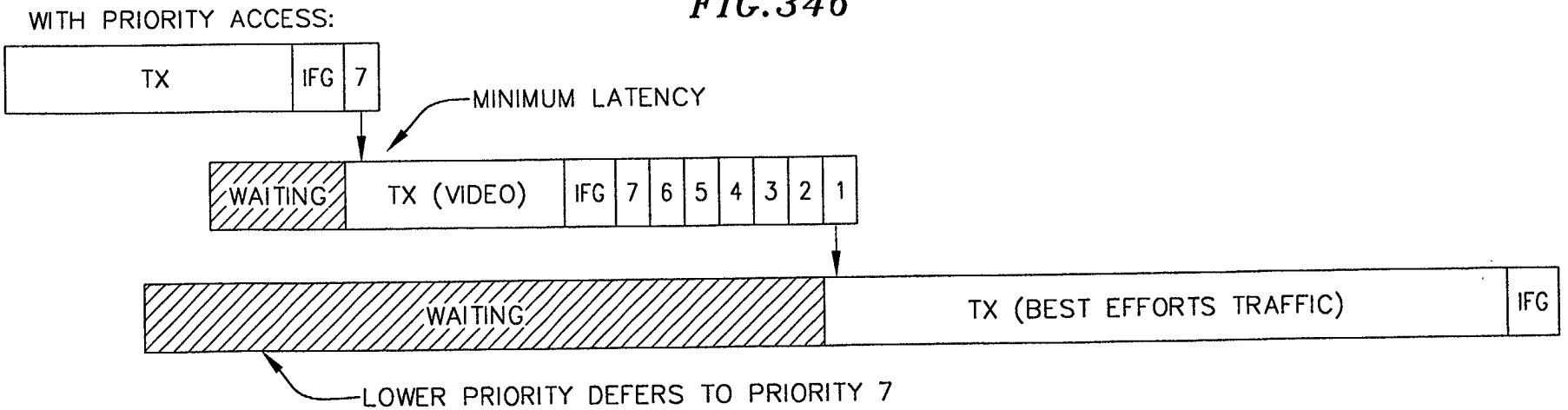

*FIG.35*

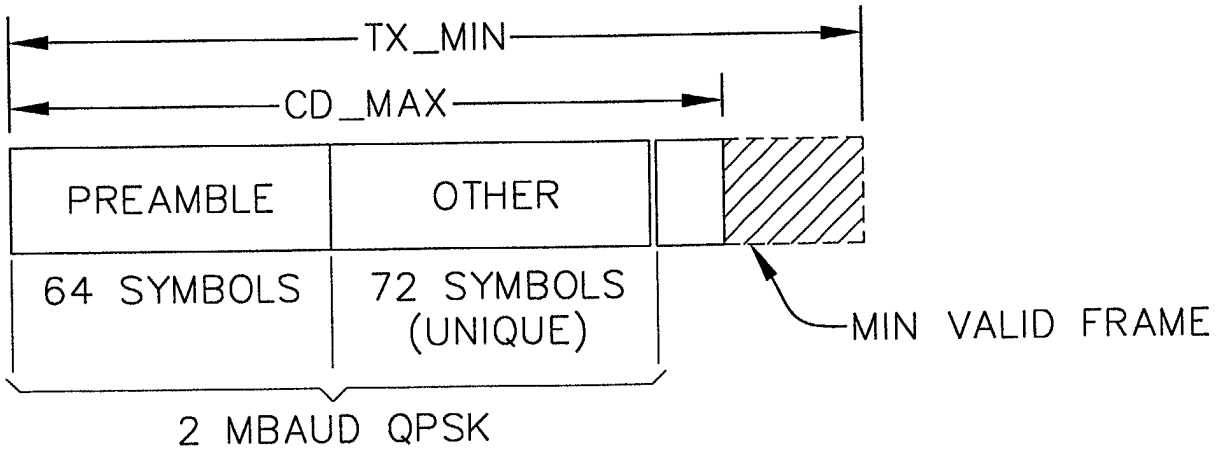
TX_MIN
CD_MAX
PREAMBLE
OTHER
64 SYMBOLS
72 SYMBOLS
(UNIQUE)
MIN VALID FRAME
2 MBAUD QPSK

*FIG.36*

| SECTION | PARAMETER | MIN | MAX | UNITS |
|---|---|---|---|---|
| BASIC CSMA | NOMINAL_RMS_VOLTAGE | 100 | – | mVrms |
| | CS_RANGE | 38 | – | dB |
| | CS_IFG | 29.0–Δ | 29.0+Δ | MICROSECONDS |
| | CS_DEFER | – | 12.0 | MICROSECONDS |
| | MINFRAMESIZE | 64 | – | OCTETS |
| | MAXFRAMESIZE | 1526 | SEE 3.3.7.1 | OCTETS |
| | TX_FRAME | 92.5 | SEE 3.3.7.1 | MICROSECONDS |
| | TX_ON | 0 | 4.0 | MICROSECONDS |
| PRIORITY ACCESS | PRI_SLOT | 21.0–Δ | 21.0+Δ | MICROSECONDS |
| COLLISION DETECTION | CD_FRAG | 70.0–Δ | 70.0+Δ | MICROSECONDS |
| | CD_MIN | 32.0 | – | MICROSECONDS |
| | CD_THRESHOLD (RECOMMENDED) | – | 92.0 | MICROSECONDS |
| | CD_RANGE | 36 | – | dB |
| | CD_OFFSET_EARLY | – | 12.0 | MICROSECONDS |
| | CD_OFFSET_LATE | – | 15.0 | MICROSECONDS |
| COLLISION RESOLUTION | ATTEMPTLIMIT | 256 | 256 | |
| | SIG_SLOT | 32.0–Δ | 32.0+Δ | MICROSECONDS |

*FIG.37*

| FIELD | LENGTH | EXPLANATION |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS |
| SA | 6 OCTETS | SOURCE ADDRESS |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK PROTOCOL FRAME. ASSIGNED TO ASSIGNEE BY IEEE) |
| SSTYPE | 1 OCTET | 0–RESERVED<br>1–RATE REQUEST CONTROL FRAME<br>2–LINK INTEGRITY SHORT FRAME<br>3–CAPABILITIES ANNOUNCEMENT<br>4–LARQ<br>5–VENDOR–SPECIFIC SHORT FORMAT TYPE<br>6–126 RESERVED<br>127 RESERVED<br>VALUES 128–255 CORRESPOND TO THE LONG SUBTYPE |
| SSLENGTH | 1 OCTET | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD (OR THE FIRST OCTET FOLLOWING SSLENGTH IF IT IS NOT DEFINED AS SSVERSION) AND ENDING WITH THE SECOND (LAST) OCTET OF THE NEXT ETHERTYPE FIELD. MIN IS 2 AND MAX IS 225 |
| SSVERSION | 1 OCTET | VERSION NUMBER OF THE CONTROL INFORMATION |
| DATA | 0–252 OCTETS | CONTROL INFORMATION |
| NEXT ETHERTYPE | 2 OCTETS | ETHERTYPE/LENGTH OF NEXT LAYER PROTOCOL, 0 IF NONE. |
| PAD | 41–0 OCTETS | PADDING REQUIRED TO MEET MINIMUM IF DATA<41 OCTETS |
| FCS | 4 OCTETS | FRAME CHECK SEQUENCE |

*FIG.38*

| FIELD | LENGTH | EXPLANATION |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS |
| SA | 6 OCTETS | SOURCE ADDRESS |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK PROTOCOL FRAME. ASSIGNED TO EPIGRAM BY IEEE) |
| LSTYPE | 2 OCTETS | 32768 RESERVED<br>32769 VENDOR-SPECIFIC LONG-FORMAT<br>32770-65534 RESERVED<br>65535 RESERVED |
| LSLENGTH | 2 OCTETS | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD (OR THE FIRST OCTET FOLLOWING SSLENGTH IF IT IS NOT DEFINED AS SSVERSION) AND ENDING WITH THE SECOND (LAST) OCTET OF THE NEXT ETHERTYPE FIELD. MIN IS 2 AND MAX IS 65535. |
| LSVERSION | 1 OCTET | VERSION NUMBER OF THE FOLLOWING PROTOCOL INFORMATION |
| DATA | LSLENGTH-3 OCTETS | LSTYPE PROTOCOL DEPENDENT DATA |
| NEXT ETHERTYPE | 2 OCTETS | ETHERTYPE/LENGTH OF NEXT LAYER PROTOCOL, 0 IF NONE. |
| PAD | 42-0 OCTETS | PAD TO MINIMUM SIZE IF NEEDED |
| FCS | 4 OCTETS | FRAME CHECK SEQUENCE |

*FIG.39*

| FIELD | LENGTH | MEANING |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS |
| SA | 6 OCTETS | SOURCE ADDRESS |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK CONTROL FRAME) |
| SSTYPE | 1 OCTET | =1 |
| SSLENGTH | 1 OCTET | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. THE MINIMUM VALUE OF SSLENGTH IS 8 FOR SSVERSION 0. |
| SSVERSION | 1 OCTET | =0 |
| OPCODE | 1 OCTET | OPERATION CODE FOR THIS CONTROL MESSAGE. |
| NUMBANDS | 1 OCTET | NUMBER OF BANDS SPECIFIED IN THIS CONTROL. EACH BAND HAS A TWO OCTET DESCRIPTOR. THE FIRST BAND REFERS TO 2 MBAUD MODULATION RATE, THE NEXT TO 4 MBAUD.<br>NUMBANDS SHALL BE 1 OR 2 ON TRANSMISSION FOR 10M8 STATIONS, AND STATIONS SHALL IGNORE BAND ENTRIES BEYOND BAND2 ON RECEIVE IF NUMBANDS IS LARGER THAN 2. THE VALUE 0 IS NOT ALLOWED. |
| NUMADDR | 1 OCTET | NUMBER OF ADDRESSES SPECIFIED IN THE PAYLOAD OF THIS CONTROL MESSAGE. NUMADDR MAY BE ZERO. THE SA IN THE ETHERNET HEADER IS ALWAYS USED, AND IS REFERRED TO IN THE FOLLOWING SECTIONS AS REFADDR0. |
| BAND1_PE | 1 OCTET | 2MBAUD, 7 MHz CARRIER: THE PE VALUE THAT SHOULD BE USED TO SEND DATA WHEN THE 2MBAUD BAND IS SELECTED. (1..8)ARE THE ONLY VALID VALUES. THE VALUE 8 IS USED TO REQUEST HPNA 1.0 TYPE FRAMES, AND IS VALID ONLY WHEN THE NETWORK IS OPERATING IN V1M2MODE, AND ONLY IN BAND 1. |
| BAND1_RANK | 1 OCTET | THE RANK ORDER OF THE REQDAS' PREFERENCE FOR THIS BAND, 1 IS HIGHEST PREFERENCE, AND THE OTHER BANDS ARE ASSIGNED SUCCESSIVELY LARGER RANK VALUES, NO TWO BANDS SHALL HAVE THE SAME RANK. |
| BAND2_PE | 1 OCTET | OPTIONAL, ONLY PRESENT IF NUMBANDS>=2.<br>4MBAUD, 7 MHz CARRIER: IF INCLUDED, THIS FIELD IS THE PE VALUE THAT SHOULD BE USED TO SEND DATA WHEN THE 4MBAUD BAND IS SELECTED, (0,9..15) ARE THE ONLY VALID VALUES. |
| BAND2_RANK | 1 OCTET | OPTIONAL, ONLY PRESENT IF NUMBANDS>=2.<br>RANK ORDER OF REQDAS' PREFERENCE FOR THIS BAND. |
| REFADDR1 | 6 OCTETS | OPTIONAL. PRESENT IF NUMADDR>=1. THE SECOND MAC ADDRESS FOR WHICH THE RATES ARE BEING SPECIFIED, TYPICALLY BROADCAST OR A MULTICAST ADDRESS. |
| REFADDR2 | 6 OCTETS | OPTIONAL. PRESENT IF NUMADDR>=2. THE THIRD MAC ADDRESS FOR WHICH THE RATES ARE BEING SPECIFIED. |
| ... | | [ADDITIONAL INSTANCES OF REFADDR, UNTIL THE NUMBER OF REFADDR FIELDS EQUALS NUMADDR] |
| NEXT ETHERTYPE | 2 OCTETS | =0 |
| PAD | | TO REACH MINFRAMESIZE IF REQUIRED |
| FCS | 4 OCTETS | FRAME CHECK SEQUENCE |

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FIG. 40

| PE | DATA RATE | MEANING |
|---|---|---|
| 0 | N/A | MEANS THIS BAND IS NOT SUPPORTED |
| 1 | 4 MBIT/S | 2 MBAUD FDQAM, 2 BITS PER BAUD |
| 2 | 6 MBIT/S | 2 MBAUD FDQAM, 3 BITS PER BAUD |
| 3 | 8 MBIT/S | 2 MBAUD FDQAM, 4 BITS PER BAUD |
| 4 | 10 MBIT/S | 2 MBAUD FDQAM, 5 BITS PER BAUD |
| 5 | 12 MBIT/S | 2 MBAUD FDQAM, 6 BITS PER BAUD |
| 6 | 14 MBIT/S | 2 MBAUD FDQAM, 7 BITS PER BAUD |
| 7 | 16 MBIT/S | 2 MBAUD FDQAM, 8 BITS PER BAUD |
| 8 | 1 MBIT/S | HPNA 1.0 |
| 9 | 8 MBIT/S | 4 MBAUD QAM, 2 BITS PER BAUD |
| 10 | 12 MBIT/S | 4 MBAUD QAM, 3 BITS PER BAUD |
| 11 | 16 MBIT/S | 4 MBAUD QAM, 4 BITS PER BAUD |
| 12 | 20 MBIT/S | 4 MBAUD QAM, 5 BITS PER BAUD |
| 13 | 24 MBIT/S | 4 MBAUD QAM, 6 BITS PER BAUD |
| 14 | 28 MBIT/S | 4 MBAUD QAM, 7 BITS PER BAUD |
| 15 | 32 MBIT/S | 4 MBAUD QAM, 8 BITS PER BAUD |

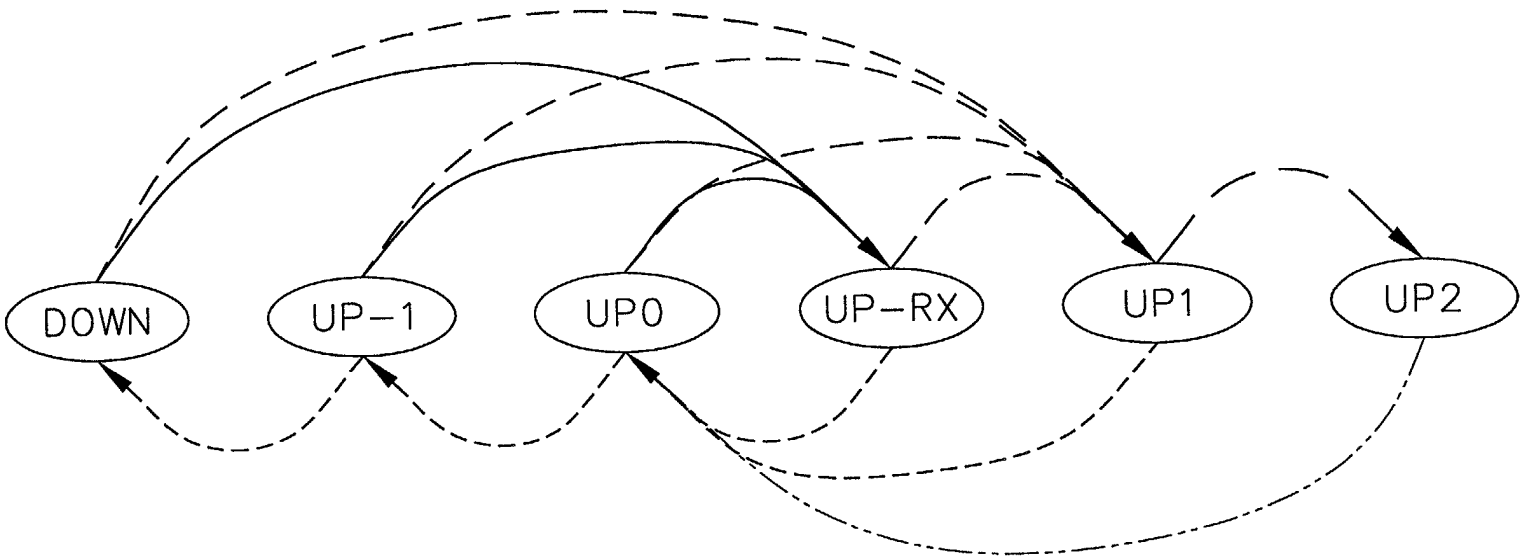
FIG. 41

| OPCODE | MEANING |
|---|---|
| 0 | RATE CHANGE REQUEST |
| 1 | RATE TEST REQUEST |
| 2 | RATE TEST REPLY |
| 3-255 | RESERVED |

*FIG.42*

| | |
|---|---|
| BAND SPECIFICATION | A PAYLOAD ENCODING (PE) AND RANK ASSOCIATED WITH A GIVEN BAND. A BAND IS A SINGLE COMBINATION OF BAUD RATE, MODULATION TYPE (E.G. QAM OR FDQAM) AND CARRIER FREQUENCY. TWO BANDS ARE DEFINED IN HPNAVZ |
| LOGICAL CHANNEL, CHANNEL | A FLOW OF FRAMES FROM A SENDER TO ONE OR MORE RECEIVERS ON A SINGLE NETWORK SEGMENT, CONSISTING OF ALL THE FRAMES WITH A SINGLE COMBINATION OF DA AND SA. |
| RECEIVER | A STATION THAT RECEIVES FRAMES SENT ON A PARTICULAR CHANNEL. IF THE DESTINATION IS A UNICAST ADDRESS THERE IS AT MOST ONE RECEIVER. IF THE DESTINATION IS A GROUP ADDRESS (INCLUDING BROADCAST), THERE MAY BE MANY RECEIVERS. |
| RECEIVER PE | THE PREFERRED PE TO BE USED ON THIS CHANNEL, AS DETERMINED BY THE RECEIVER. |
| RRCF | RATE REQUEST CONTROL FRAME. SENT FROM THE RECEIVER TO THE SENDER TO EFFECT A CHANGE IN PE. |
| REFADDR0 | THE SA IN THE ETHERNET HEADER OF THE RRCF FRAME. THIS IS THE DA OF THE RECEIVER (FOR THE CHANNEL), AND IS ALWAYS USED BY THE CHANNEL SENDER AS THE FIRST REFADDR PROCESSED. |
| REFADDR1.. REFADDR<n> | OTHER ADDRESSES INCLUDING BROADCAST AND MULTICAST ADDRESSES FOR WHICH THE RECEIVER IS INDICATING RATE INFORMATION TO THE SENDER. THE CHANNEL RECEIVER'S STATION ADDRESS (REFADDR0) SHOULD NOT BE PUT IN THE LIST OF ADDITIONAL REFADDR'S.<br>NOTE 1: AT LEAST ONE REFADDR FIELD IS NECESSARY TO SUPPORT RATE NEGOTIATION FOR BROADCAST AND MULTICAST ADDRESSES SINCE THESE CANNOT BE USED AS THE SOURCE ADDRESS IN THE ETHERNET HEADER. |
| SENDER | THE SENDING STATION FOR A CHANNEL, USUALLY THE STATION OWNING THE SOURCE MAC ADDRESS. |
| SENDER PE | THE PREFERRED PE ASSOCIATED WITH A CHANNEL, AS NOTED BY THE SENDER. |

*FIG.43a*




——►RECEIVE ANY NON-BROADCAST FRAME OR LINK INDICATION

– – ►RECEIVE A FRAME WITH DA==BROADCAST (0xFFFFFFFFFFFF)-SET SA1=SA

— –►RECEIVE A FRAME WITH DA==BROADCAST (0xFFFFFFFFFFFF) AND SA !=SA1

-----►TIMEOUT OF 1 SECOND FREE-RUNNING TIMER-SEND LICF, REINITIALIZE FORCE_SEND

-·-·-►TIMEOUT-IF FORCE_SEND==0 THEN SEND LICF, REINIT FORCE_SEND ELSE DECREMENT FORCE_SEND

*FIG.43b*

| | DOWN | UP−1 | UP0 | UP−RX | UP1 | UP2 |
|---|---|---|---|---|---|---|
| RECEIVE 1.0 LINK INDICATION OR ANY NON-BROADCAST FRAME | UP−RX<br>(NONE) | UP−RX<br>(NONE) | UP−RX<br>(NONE) | UP−RX<br>(NONE) | UP1<br>(NONE) | UP2<br>(NONE) |
| RECEIVE BROADCAST FRAME WITH SA=SA1 | UP1<br>SET SA1<−SA | UP1<br>SET SA1<−SA | UP1<br>SET SA1<−SA | UP1<br>SET SA1<−SA | UP1<br>(NONE) | UP2<br>(NONE) |
| RECEIVE BROADCAST FRAME WITH SA !=SA1 | UP1<br>SET SA1<−SA | UP1<br>SET SA1<−SA | UP1<br>SET SA1<−SA | UP1<br>SET SA1<−SA | NATIVE: UP2<br>COMPAT: UP1<br>(NONE) | UP2<br>(NONE) |
| TIMEOUT AND FORCE_SEND=0 | DOWN<br>SEND LICF,REINIT FORCE_SEND | DOWN<br>SEND LICF,REINIT FORCE_SEND | UP−1<br>SEND LICF,REINIT FORCE_SEND | UP0<br>SEND LICF,REINIT FORCE_SEND | UP0<br>SEND LICF,REINIT FORCE_SEND | UP0<br>SEND LICF,REINIT FORCE_SEND |
| TIMEOUT AND FORCE_SEND>0 | DOWN<br>SEND LICF,REINIT FORCE_SEND | DOWN<br>SEND LICF,REINIT FORCE_SEND | UP−1<br>SEND LICF,REINIT FORCE_SEND | UP0<br>SEND LICF,REINIT FORCE_SEND | UP0<br>SEND LICF,REINIT FORCE_SEND | UP0<br>DECREMENT FORCE_SEND |

*FIG.44*

| FIELD | LENGTH | MEANING |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS (FF.FF.FF.FF.FF.FF) |
| SA | 6 OCTETS | SOURCE ADDRESS |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK CONTROL FRAME) |
| SSTYPE | 1 OCTET | =2 |
| SSLENGTH | 1 OCTET | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. MINIMUM IS 4 FOR SSVERSION 0. |
| SSVERSION | 1 OCTET | =0 |
| LI_PAD | 1 OCTET | IGNORED ON RECEPTION. |
| NEXT ETHERTYPE | 2 OCTETS | =0 |
| PAD | 41 OCTETS | ANY VALUE OCTET |
| FCS | 4 OCTETS | |

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*FIG.45*

| FIELD | LENGTH | MEANING |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS(FF.FF.FF.FF.FF.FF) |
| SA | 6 OCTETS | SOURCE ADDRESS OF THE STATION THAT TRANSMITTED THIS FRAME |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK CONTROL FRAME) |
| SSTYPE | 1 OCTET | =3 |
| SSLENGTH | 1 OCTET | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. MINIMUM IS 32 FOR SSVERSION 0. |
| SSVERSION | 1 OCTET | =0 |
| CSA_ID_SPACE | 1 OCTET | IDENTIFIES THE REGISTRATION SPACE OF CSA_MFR_ID<br>0-UNSPECIFIED<br>1-JEDEC<br>2-PCI |
| CSA_MFR_ID | 2 OCTETS | HW MANUFACTURER ID-IDENTIFIES THE MANUFACTURER OF THE PHY CONTROLLER CHIP. THE PURPOSE OF THIS FIELD PLUS THE PART NUMBER AND REVISION IS TO IDENTIFY SPECIFIC IMPLEMENTATIONS OF THE PHY SPECIFICATION. THIS IS NOT A BOARD OR ASSEMBLY-LEVEL IDENTIFIER. |
| CSA_PART_NO | 2 OCTETS | HW MANUFACTURER PART NUMBER-THE PART NUMBER OF THE PHY CONTROLLER CHIP. |
| CSA_REV | 1 OCTET | HW REVISION |
| CSA_OPCODE | 1 OCTET | 0-ANNOUNCE<br>1-REQUEST |
| CSA_MTU | 2 OCTETS | MAXIMUM SIZE LINK-LEVEL PDU THIS RECEIVER ACCEPTS IN OCTETS, THE DEFAULT VALUE IS 1526 OCTETS. THIS IS ALSO THE MINIMUM VALUE THAT SHALL BE ACCEPTED BY ALL ILINE10 STATIONS. |
| CSA_SA | 6 OCTETS | SOURCE ADDRESS OF THE STATION THAT GENERATED THIS CSA FRAME |
| CSA_PAD | 2 OCTETS | RESERVED FOR VERSION 0. SHALL BE SENT AS 0, IGNORED ON RECEPTION. |
| CSA_ CURRENTTXSET | 4 OCTETS | CONFIGURATION FLAGS, PLUS ALL CURRENT IN-USE STATUS FOR THIS STATION. |
| CSA_ OLDESTTXSET | 4 OCTETS | A COPY OF THE "OLDEST" TX FLAGS FOR THIS STATIONS, FROM THE PERIOD ENDING AT LEAST ONE PERIOD (MINUTE) EARLIER. |
| CSA_ CURRENTRXSET | 4 OCTETS | THE UNION OF RECENT FLAGS RECEIVED FROM OTHER STATIONS. |
| NEXT ETHERTYPE | 2 OCTETS | =0 |
| PAD | | PAD TO REACH MINFRAMESIZE IF NECESSARY |
| FCS | 4 OCTETS | |

| Octet | Field | Length | Description |
|---|---|---|---|
| Flags0 | TxPriority7 | 1 | Station is(was) transmitting frames with LL priority 7. (always set) |
| | TxPriority6 | 1 | Station is(was) transmitting frames with LL priority 6. |
| | TxPriority5 | 1 | Station is(was) transmitting frames with LL priority 5. |
| | TxPriority4 | 1 | Station is(was) transmitting frames with LL priority 4. |
| | TxPriority3 | 1 | Station is(was) transmitting frames with LL priority 3. |
| | TxPriority2 | 1 | Station is(was) transmitting frames with LL priority 2. |
| | TxPriority1 | 1 | Station is(was) transmitting frames with LL priority 1. |
| | TxPriority0 | 1 | Station is(was) transmitting frames with LL priority 0. (always set) |
| Flags1 | Reserved | 6 | Shall be sent as 0 and ignored by 2.0 stations when received. |
| | No_V1M2_Frames | 1 | This station does not support the reception or transmission of compatibility frames (V1M2 frames). |
| | Supports 4Mbaud | 1 | This station supports 4 megabaud payload encodings. |
| Flags2 | Reserved | 8 | Shall be sent as 0 and ignored by 2.0 stations when received. |
| Flags3 | ConfigV2 | 1 | Force use of 10M8 mode, defers to Config1 and ConfigV1M2. |
| | ConfigV1M2 | 1 | Force use of V1M2 mixed mode, defers to ConfigV1. |
| | ConfigV1 | 1 | Force use of HPNA 1.x mode, highest precedence of config flags. |
| | Reserved | 2 | Shall be sent as 0 and ignored by 2.0 stations when received. |
| | Highest Version | 3 | This station's highest supported HPNA version:<br>0x000 – Reserved<br>0x001 – HPNA1.0<br>0x010 – iLine10<br>0x011-0x111 Reserved |
| | | | |

Fig. 46

| | |
|---|---|
| DeleteSet | A computed value used to detect newly removed status information. |
| NewRxFlags, ReallyNewRxFlags | Computed values used to detect new status flags. |

Fig. 47

| | |
|---|---|
| CSP_Timer | A free-running timer with a period of 60 seconds. |
| RetransmitTimer | A one-shot timer, set to a random interval in the range 1 ms to 1000 ms, inclusive, after sending a CSA in which CSA_CurrentTxSet and CSA_OldestTxSet are different, or when a CSA is received with the CSA_Opcode set to 1 (Request). This timer is cancelled if a second CSA is sent as a result of the CSP_Timer expiring. |

Fig. 48

| | |
|---|---|
| NewTxSet | The set of flags announced during the current CS period, updated immediately when a new link layer priority is used or new volatile status is set. When the CSP_Timer expires, CurrentTxSet is given the value of NewTxSet, and NewTxSet is reset to the default set. |
| PreviousTxSet | The set of flags that were announced during the previous CS period (the ending value of NewTxSet from the previous CS period). |
| OldestTxSet | The set of flags rolled over from PreviousTxSet at the end of the previous CS period (the value of PreviousTxSet from the previous CS period). Flags that are present in OldestTxSet and missing from PreviousTxSet were not actively used or detected (by the sender) for an entire CS period, and will be deleted. This set is sent in CSA frames as CSA_OldestTxSet. |
| NewRxSet | The union of all CSA_CurrentTxSet flags received in CSAs from other stations during the current CS period. This is rolled over into PreviousRxSet at the expiration of the CSP_Timer, then reset to the empty set (0).<br><br>A volatile status flag (one of the priority flags) in this set may subsequently be deleted if the only station previously announcing that flag stops using it. The deletion from that station's CurrentTxSet is noted by the difference from its OldestTxSet. The fact that it was the only sender is noted by the absence of the flag in that station's CurrentRxSet, indicating that it has received the flag from no other stations.<br><br>If deleted from NewRxSet, a flag shall also be deleted from PreviousRxSet. |
| PreviousRxSet | The set of announced flags received during the previous CS period (the ending value of NewRxSet from the previous CS period). A flag may be deleted from this set, as described under NewRxSet above. |

Fig. 49

| | |
|---|---|
| **CurrentTxSet** | The set of flags that were announced during the previous CS period plus any new status and priority flags (or changed configuration/options flags) used during the current CS period, i.e. the union of PreviousTxSet and NewTxSet. This set is sent in CSA frames as CSA_CurrentTxSet. |
| **CurrentRxSet** | The union of NewRxSet, PreviousRxSet. This set is sent in CSA frames as CSA_CurrentRxSet. |
| **CurrentInUseSet** | The union of CurrentTxSet and CurrentRxSet. This set is used to determine the operational mode of the station and to modify the mapping between the LL priority of the frame and the actual PHY priority usage. |

Fig. 50

*FIG.51a*

| CURRENTINUSE PRIORITIES (ANY) | | | | | | | | | TX LL PRIORITY | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| A | N | Y | T | X | S | E | T | | DEFAULT TX PHY PRIORITIES | | | | | | | |
| | | | | | | | | | 2 | 0 | 1 | 3 | 4 | 5 | 7 | 6 |

*FIG.51b*

| CURRENTINUSE PRIORITIES (LL) | | | | | | | | | TX LL PRIORITY | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | | | | | | | 7 | | REMAPPED TX PHY PRIORITIES | | | | | | | |
| | | | | | | | | | 6 | 5 | 5 | 6 | 6 | 6 | 6 | 7 |
| 0 | | | | | | 6 | 7 | | 5 | 4 | 4 | 5 | 5 | 5 | 7 | 6 |
| 0 | 1 | | | 4 | | | 7 | | 5 | 4 | 4 | 5 | 6 | 6 | 7 | 7 |
| 0 | | | 3 | | 5 | 6 | 7 | | 3 | 2 | 2 | 4 | 4 | 5 | 7 | 6 |

*FIG.52a*

| FIELD | LENGTH | MEANING |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS |
| SA | 6 OCTETS | SOURCE ADDRESS |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK CONTROL FRAME) |
| SSTYPE | 1 OCTET | =4 |
| SSLENGTH | 1 OCTET | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. SSLENGTH IS 6 FOR SSVERSION 0. |
| SSVERSION | 1 OCTET | =0 |
| LARQ_HDR DATA | 3 OCTETS | LARQ CONTROL HEADER DATA WITH LARQ_CTL BIT=1,LARQ_NACK=0. |
| NEXT ETHERTYPE | 2 OCTETS | =0 |
| PAD | 38 OCTETS | |
| FCS | 4 OCTETS | FRAME CHECK SEQUENCE |

*FIG.52b*

| FIELD | LENGTH | MEANING |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS |
| SA | 6 OCTETS | SOURCE ADDRESS |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK CONTROL FRAME) |
| SSTYPE | 1 OCTET | =4 |
| SSLENGTH | 1 OCTET | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. SSLENGTH IS 12 FOR NACK FRAMES WITH SSVERSION 0. |
| SSVERSION | 1 OCTET | =0 |
| LARQ_HDR DATE | 3 OCTETS | LARQ CONTROL HEADER DATA WITH LARQ_CTL BIT=1,LARQ_NACK=1..7. |
| NACK_DA | 6 OCTETS | ORIGINAL DESTINATION ADDRESS |
| NEXT ETHERTYPE | 2 OCTETS | =0 |
| PAD | 32 OCTETS | |
| FCS | 4 OCTETS | FRAME CHECK SEQUENCE |

*FIG.52c*

| FIELD | LENGTH | MEANING |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS (FROM ORIGINAL ETHERNET PDU) |
| SA | 6 OCTETS | SOURCE ADDRESS (FROM ORIGINAL ETHERNET PDU) |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK CONTROL FRAME) |
| SSTYPE | 1 OCTET | =4 |
| SSLENGTH | 1 OCTET | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. SSLENGTH IS 6 FOR SSVERSION 0.=6 |
| SSVERSION | 1 OCTET | =0 |
| LARQ_HDR DATA | 3 OCTETS | LARQ ENCAPSULATION HEADER DATA (WITH LARQ_CTL BIT=0) |
| NEXT ETHERTYPE | 2 OCTETS | FROM ORIGINAL ETHERNET PDU |
| PAYLOAD | MIN 46 OCTETS | FROM ORIGINAL ETHERNET PDU PAYLOAD |
| FCS | 4 OCTETS | FRAME CHECK SEQUENCE |

*FIG.52d*

| OCTET | FIELD | LENGTH | MEANING |
|---|---|---|---|
| FLAGS0 | LARQ_MULT | 1 BIT | MULTIPLE RETRANSMISSION FLAG. 0 IN THE ORIGINAL TRANSMISSION OF A DATA FRAME. FOR RETRANSMITTED FRAMES (LARQ_RTX=1), SET TO THE VALUE OF LARQ_MULT IN THE NACK FRAME THAT CAUSED THE RETRANSMISSION. THIS CAN BE USED BY RECEIVERS TO MEASURE THE ROUND-TRIP TIMES ASSOCIATED WITH THE MISS/NACK/RECEIVE-RTX PROCESS. |
| | LARQ_RTX | 1 BIT | 0 FOR FIRST TRANSMISSION OF A FRAME, 1 IF FRAME IS RETRANSMITTED. STATIONS NOT IMPLEMENTING LARQ SHALL DROP ANY DATA FRAME IF THIS BIT IS 1. |
| | LARQ_NORTX | 1 BIT | 0 IF IMPLEMENTATION SUPPORTS RETRANSMISSION, 1 IF ONLY PRIORITY IS MEANINGFUL. MAY BE USED ON A PERCHANNEL BASIS. |
| | LARQ_NEWSEQ | 1 BIT | 1 IF THE SEQUENCE NUMBER SPACE FOR THE CHANNEL HAS BEEN RESET, AND OLDER SEQUENCE NUMBERS SHOULD NOT BE NACKED, 0 OTHERWISE. |
| | LARQ_CTL | 1 BIT | "0" WHEN IN ENCAPSULATION FORMAT |
| | PRIORITY | 3 BITS | LINK LAYER PRIORITY OF THIS FRAME |
| FLAGS1_SEQ0 | RESERVED | 4 BITS | RESERVED, SHALL BE 0 |
| | LARQ_SEQ_HIGH | 4 BITS | HIGH 4 BITS OF SEQUENCE NUMBER |
| SEQ1 | LARQ_SEQ_LOW | 8 BITS | LOW 8 BITS OF SEQUENCE NUMBER |

Petitioner's Exhibit 1003, p. 0258

*FIG.52e*

| OCTET | FIELD | LENGTH | MEANING |
|---|---|---|---|
| FLAGS0 | LARQ_MULT | 1 BIT | MULTIPLE RETRANSMISSION FLAG. 0 IN THE FIRST NACK SENT FOR A GIVEN SEQUENCE NUMBER, 1 IN ALL RETRANSMITTED NACKS. |
| | LARQ_NACK | 3 BITS | NACK COUNT<br>IF 0 IN A LARQ CONTROL FRAME, THEN THIS IS A REMINDER. |
| | LARQ_CTL | 1 BIT | SET TO 1 FOR LARQ CONTROL HEADER DATA FORMAT |
| | PRIORITY | 3 BITS | LINK LAYER PRIORITY OF THIS FRAME |
| FLAGS1_SEQ0 | RESERVED | 4 BITS | RESERVED, SHALL BE 0 |
| | LARQ_SEQ_HIGH | 4 BITS | HIGH 4 BITS OF SEQUENCE NUMBER |
| SEQ1 | LARQ_SEQ_LOW | 8 BITS | LOW 8 BITS OF SEQUENCE NUMBER |

1363/26/5,363,569

*FIG.52f.1*

| | |
|---|---|
| CONTROL FRAME | A FRAME GENERATED BY A LARQ PROTOCOL MODULE THAT CONTAINS ONLY A LARQ PROTOCOL HEADER AS ITS PAYLOAD. |
| CURRENT SEQUENCE NUMBER | THE MOST RECENTLY RECEIVED NEW SEQUENCE NUMBER FOR A CHANNEL. |
| DATA FRAME | ANY STANDARD ETHERNET FRAME FROM HIGHER (THAN LARQ) PROTOCOL LAYERS. A LARQ-ENABLED STATION ENCAPSULATES THE ORIGINAL PAYLOAD OF AN ETHERNET FRAME BY INSERTING A LARQ HEADER (SHORTER FORM CONTROL HEADER WITH LARQ_HDR DATA) BETWEEN THE SOURCE ADDRESS AND THE REMAINDER OF THE FRAME BEFORE THE FRAME IS PASSED DOWN TO THE DRIVER FOR TRANSMISSION ON THE NETWORK. |
| FORGET TIMER | AN IMPLEMENTATION DEPENDENT MECHANISM TO ALLOW A RECEIVER TO RESET THE SEQUENCE NUMBER SPACE OF A CHANNEL WHEN A RECEIVED SEQUENCE NUMBER IS NOT THE NEXT EXPECTED (CURRENT SEQUENCE NUMBER+1). ONE SECOND IS A SUGGESTED DEFAULT VALUE. |
| HOLD TIMER, LOST TIMER | AN IMPLEMENTATION DEPENDENT TIMING MECHANISM THAT LIMITS THE TIME A RECEIVER WILL HOLD ONTO A RECEIVED FRAME WHILE WAITING FOR A MISSING FRAME TO BE RETRANSMITTED. CONCEPTUALLY, THERE IS ONE SUCH TIMER PER MISSING SEQUENCE NUMBER. THE TIMER INTERVAL IS MAXIMUM HOLD INTERVAL. |
| LOGICAL CHANNEL, CHANNEL | A FLOW OF FRAMES FROM A SENDER TO ONE OR MORE RECEIVERS ON A SINGLE NETWORK SEGMENT CONSISTING OF ALL THE FRAMES WITH A SINGLE COMBINATION OF DESTINATION ADDRESS, SOURCE ADDRESS, AND LINK LAYER PRIORITY. |
| NACK, NACK, NACK | AN INDICATION FROM A RECEIVER TO A SENDER REQUESTING RETRANSMISSION OF ONE OR MORE FRAMES. ALSO, THE ACTION OF PROVIDING SUCH AN INDICATION. E.G. "TO NACK A SEQUENCE NUMBER" MEANING TO SEND A NACK INDICATION. |
| NACK TIMER | AN IMPLEMENTATION DEPENDENT TIMING MECHANISM USED BY A RECEIVER TO RETRANSMIT NACKS FOR MISSING SEQUENCE NUMBERS. CONCEPTUALLY, THERE IS ONE SUCH TIMER PER MISSING SEQUENCE NUMBER PER LOGICAL CHANNEL. THE TIMER IS RESET EACH TIME A NACK IS SENT FOR A SEQUENCE NUMBER. THE TIMER INTERVAL IS NACK RETRANSMISSION INTERVAL. |
| NEW | A NEW SEQUENCE NUMBER IS ONE WHOSE DIFFERENCE FROM THE CURRENT SEQUENCE NUMBER FOR THE CHANNEL, MODULO THE SIZE OF THE SEQUENCE NUMBER SPACE AND CONSIDERED AS A SIGNED INTEGER, IS GREATER THAN 0. IN PARTICULAR, THE NUMBERS (CURRENT+1) THROUGH (CURRENT+2047). |
| OLD | AN OLD SEQUENCE NUMBER IS ONE WHOSE DIFFERENCE FROM THE CURRENT SEQUENCE NUMBER FOR THE CHANNEL, MODULO THE SIZE OF THE SEQUENCE NUMBER SPACE AND CONSIDERED AS A SIGNED INTEGER, IS LESS THAN OR EQUAL TO 0. IN PARTICULAR, THE NUMBERS (CURRENT-2048) THROUGH (CURRENT) ARE OLD. NOTE, HOWEVER, THAT MOST OF THE OLD SEQUENCE NUMBERS ARE ALSO OUT-OF-SEQUENCE. |

Patent 5,963,554

*FIG.52f.2*

| | |
|---|---|
| OUT OF SEQUENCE | ANY SEQUENCE NUMBER THAT FALLS OUTSIDE A REASONABLE RANGE, OLD OR NEW, OF THE CURRENT SEQUENCE NUMBER FOR A LOGICAL CHANNEL IS CONSIDERED OUT OF SEQUENCE. IT IS RECOMMENDED THAT PLUS OR MINUS TWICE THE VALUE OF MAXIMUMSAVELIMIT (DEFINED BELOW) BE USED AS THE "REASONABLE RANGE" WHEN CHECKING FOR OUT OF SEQUENCE. |
| RECEIVER | A STATION THAT RECEIVES FRAMES SENT ON A PARTICULAR CHANNEL. IF THE DESTINATION ADDRESS IS A UNICAST ADDRESS THERE IS AT MOST ONE RECEIVER. IF THE DESTINATION ADDRESS IS A GROUP ADDRESS (INCLUDING BROADCAST), THEN THERE MAY BE MANY RECEIVERS. |
| REMINDER | A CONTROL FRAME SENT BY THE CHANNEL SENDER WITH THE MOST RECENTLY USED SEQUENCE NUMBER FOR A CHANNEL WHICH HAS BEEN INACTIVE FOR REMINDER INTERVAL AFTER ITS MOST RECENT DATA FRAME. |
| REMINDER TIMER | AN IMPLEMENTATION DEPENDENT TIMING MECHANISM USED BY A SENDER TO GENERATE A REMINDER FRAME AFTER A PERIOD OF INACTIVITY FOR A CHANNEL. THE TIMER IS RESET EACH TIME A NEW DATA FRAME IS TRANSMITTED. CONCEPTUALLY, THERE IS ONE SUCH TIMER PER CHANNEL. THE TIMER INTERVAL IS REMINDER INTERVAL. |
| SAVE TIMER | AN IMPLEMENTATION DEPENDENT TIMING MECHANISM THAT LIMITS THE TIME A SENDER WILL SAVE A FRAME WAITING FOR RETRANSMISSION REQUESTS. THE TIMER INTERVAL IS MAXIMUM SAVE INTERVAL. |
| SENDER | THE SENDING STATION FOR A CHANNEL, USUALLY THE STATION OWNING THE SOURCE MAC ADDRESS. |
| SEQUENCE NUMBERS | SEQUENCE NUMBERS ARE MAINTAINED SEPARATELY FOR EACH LOGICAL CHANNEL BY THE SENDER. |

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*FIG.53*

| | |
|---|---|
| SEND SEQUENCE NUMBER | THE SEQUENCE NUMBER OF THE MOST RECENTLY TRANSMITTED DATA FRAME. |
| REMINDER TIMER INTERVAL | A FIXED INTERVAL. THE DEFAULT IS 50 MS. LOWER VALUES WILL INCREASE THE OVERHEAD OF REMINDERS ON NETWORK LOAD, WHILE HIGHER VALUES INCREASE THE LATENCY FOR END-OF-SEQUENCE FRAMES REQUIRING RETRANSMISSION. IMPLEMENTATIONS SHOULD NOT USE VALUES OUTSIDE OF THE RANGE 25-75 MS, BASED ON 150 MS MAXIMUM SAVE AND HOLD TIMES. |
| MINIMUM RETRANSMISSION INTERVAL | AN INTERVAL USED TO PREVENT TOO-FREQUENT RETRANSMISSIONS OF A SINGLE FRAME. MOST IMPORTANT FOR MULTICAST CHANNELS. THE DEFAULT IS 10 MS. |
| MAXIMUM SAVE LIMIT | THE MAXIMUM NUMBER OF FRAMES THAT WILL BE SAVED FOR A SINGLE LOGICAL CHANNEL. THIS IMPLEMENTATION DEPENDENT, AND VARIES WITH THE MAXIMUM FRAME RATE THE SENDER IS EXPECTED TO SUPPORT. VALUES OF 100 OR MORE CAN BE USEFUL FOR HIGH-SPEED APPLICATIONS SUCH AS VIDEO. |
| MAXIMUM SAVE INTERVAL | THE MAXIMUM TIME THAT THE SENDER WILL NORMALLY SAVE A FRAME FOR POSSIBLE RETRANSMISSION. THE DEFAULT IS 150 MS. |

*FIG.54*

| | |
|---|---|
| CURRENT SEQUENCE NUMBER | THE MOST RECENT SEQUENCE NUMBER RECEIVED IN A LARQ HEADER FOR THE CHANNEL, WHETHER IN A DATA FRAME OR A REMINDER CONTROL FRAME. |
| OLDEST MISSING SEQUENCE NUMBER | THE OLDEST SEQUENCE NUMBER FOR A FRAME NOT YET RECEIVED WHICH HAS NOT BEEN DECLARED LOST. |
| MAXIMUM HOLD INTERVAL | THE LONGEST INTERVAL THAT A FRAME WILL BE HELD AWAITING AN EARLIER MISSING FRAME. THE DEFAULT IS TO USE THE SAME VALUE AS MAXIMUM SAVE INTERVAL, WHICH HAS A DEFAULT OF 150 MS. |
| MAXIMUM RECEIVE LIMIT | THE MAXIMUM NUMBER OF FRAMES THAT A RECEIVER WILL BUFFER WHILE AWAITING AN EARLIER MISSING FRAME. THE DEFAULT SHOULD NORMALLY BE THE SAME AS THE MAXIMUM SAVE LIMIT. |
| NACK RETRANSMISSION INTERVAL | THE INTERVAL AFTER WHICH A RECEIVER WILL RETRANSMIT A NACK CONTROL FRAME FOR A MISSING SEQUENCE NUMBER, WITH THE EXPECTATION THAT EARLIER NACK CONTROL FRAMES OR DATA FRAME RETRANSMISSIONS WERE LOST. THE DEFAULT FOR FIXED IMPLEMENTATIONS IS 20 MS. |

US 6,754,706 B1

*FIG.55a*

| FIELD | LENGTH | MEANING |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS |
| SA | 6 OCTETS | SOURCE ADDRESS |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK CONTROL FRAME) |
| SSTYPE | 1 OCTET | =5 |
| SSLENGTH | 1 OCTET | NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. SSLENGTH SHALL BE>= 6 FOR SSVERSION 0. |
| SSVERSION | 1 OCTET | =0 |
| VENDOR OUI | 3 OCTETS | AN IEEE ASSIGNED ORGANIZATIONALLY UNIQUE IDENTIFIER |
| CONTROL DATA | 0-249 OCTETS | VENDOR SPECIFIC CONTROL DATA |
| NEXT ETHERTYPE | 2 OCTETS | = NEXT ETHERTYPE IF AN ENCAPSULATION FORMAT, OR 0 IF NO ENCAPSULATED FRAME |
| PAD | 0-38 OCTETS | ANY VALUE OCTET |
| FCS | 4 OCTETS | |

*FIG.55b*

| FIELD | LENGTH | MEANING |
|---|---|---|
| DA | 6 OCTETS | DESTINATION ADDRESS |
| SA | 6 OCTETS | SOURCE ADDRESS |
| ETHERTYPE | 2 OCTETS | 0x886c (LINK CONTROL FRAME) |
| LSTYPE | 2 OCTETS | =32769 |
| LSLENGTH | 2 OCTETS | NUMBER OF ADDITIONAL OCTETS STARTING WITH THE LSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. LSLENGTH SHALL BE>6 FOR LSVERSION 0. |
| LSVERSION | 1 OCTET | =0 |
| VENDOR OUI | 3 OCTETS | AN IEEE ASSIGNED ORGANIZATIONALLY UNIQUE IDENTIFIER |
| CONTROL DATA | 1-65531 OCTETS | VENDOR SPECIFIC DATA |
| NEXT ETHERTYPE | 2 OCTETS | = NEXT ETHERTYPE IF AN ENCAPSULATION FORMAT, OR 0 IF NO ENCAPSULATED FRAME |
| PAD | 40-0 OCTETS | IF NEEDED TO MAKE MINIMUM SIZE FRAME. SHOULD BE ZERO. |
| FCS | 4 OCTETS | |

*FIG.56*

| CARRIER SENSE STATE | OUTPUT EVENTS |
|---|---|
| INIT | ENERGY<=0.<br>ONLY START-OF-PREAMBLE EVENTS CHECKED. |
| IDLE | ONLY START-OF-PREAMBLE EVENTS CHECKED. |
| BUSY | ONLY END-OF-PREAMBLE EVENTS CHECKED. |
| TRANSMIT | ONLY START-OF-PREAMBLE EVENTS CHECKED(COLLISION DETECTION) |

*FIG.57*

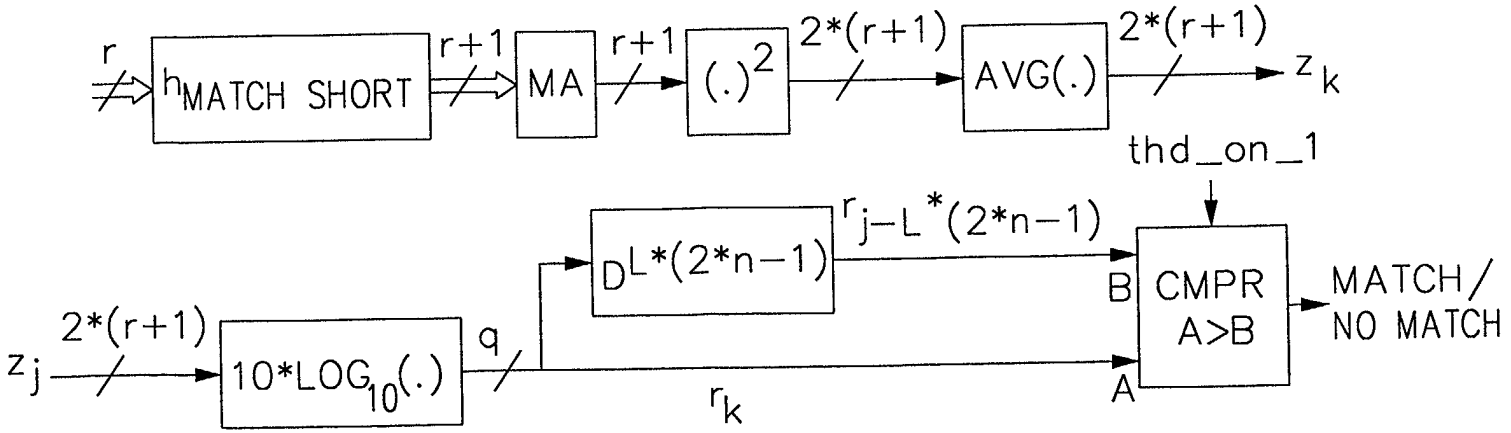

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*FIG.58*

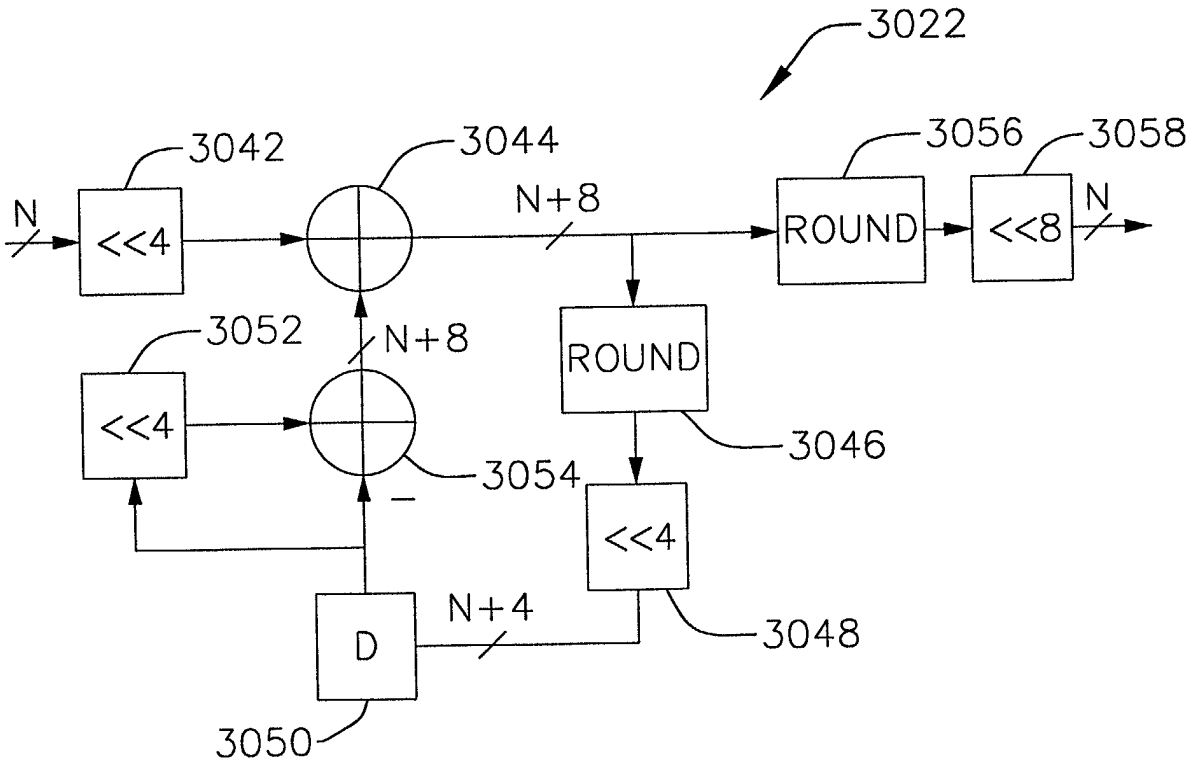


FIG. 59

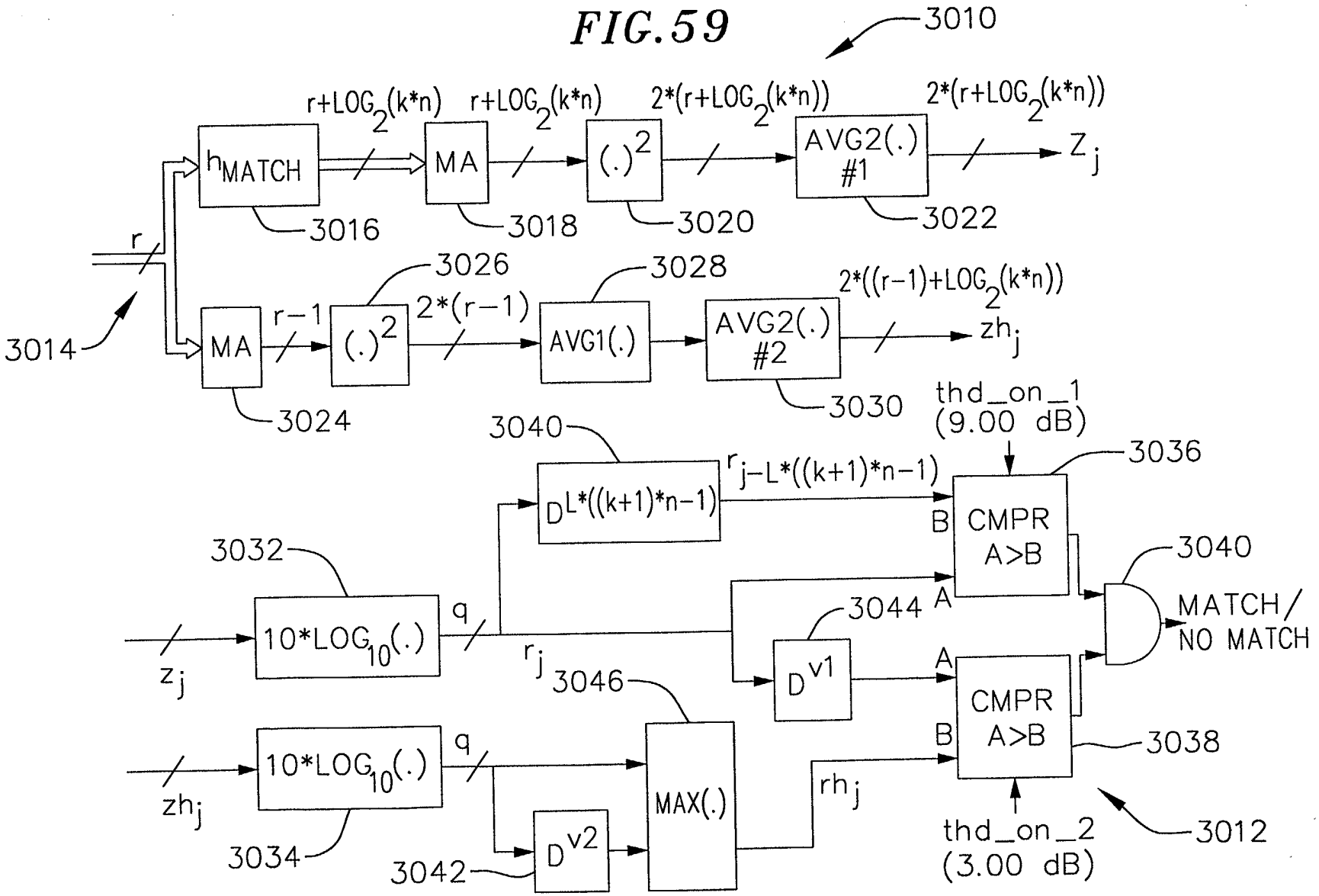

3010
r+LOG2(k*n)
r+LOG2(k*n)
2*(r+LOG2(k*n))
2*(r+LOG2(k*n))
hMATCH
MA
(.)2
AVG2(.) #1
Zj
3016
3018
3020
3022
r
3014
3026
3028
2*((r-1)+LOG2(k*n))
MA
r-1
(.)2
2*(r-1)
AVG1(.)
AVG2(.) #2
zhj
3024
3030
thd_on_1 (9.00 dB)
3040
rj-L*((k+1)*n-1)
3036
DL*((k+1)*n-1)
B
CMPR A>B
3040
3032
A
MATCH/ NO MATCH
10*LOG10(.)
q
3044
zj
rj
Dv1
A
3046
CMPR A>B
B
3038
10*LOG10(.)
q
MAX(.)
rhj
zhj
3034
Dv2
3042
thd_on_2 (3.00 dB)
3012

FIG.60

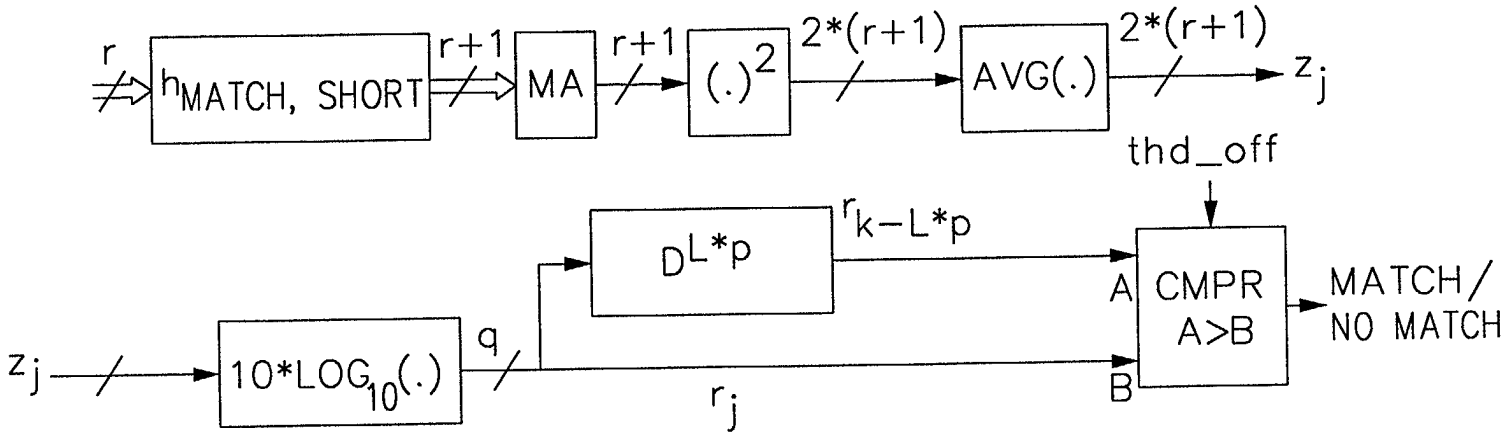

r
h MATCH, SHORT
r+1
MA
r+1
(.)2
2*(r+1)
AVG(.)
2*(r+1)
zj
thd_off
DL*p
rk−L*p
A
CMPR
A>B
MATCH/
NO MATCH
zj
10*LOG10(.)
q
B
rj

FIG.61

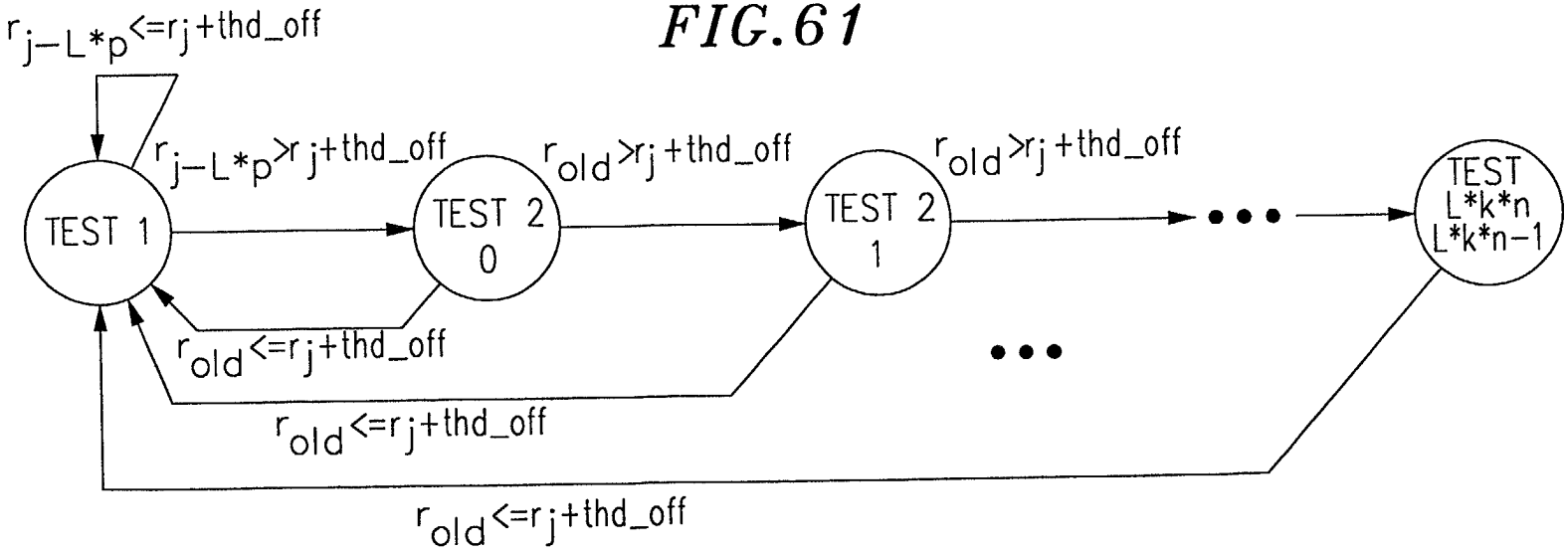

rj−L*p<=rj+thd_off
rj−L*p>rj+thd_off
rold>rj+thd_off
rold>rj+thd_off
TEST 1
TEST 2
0
TEST 2
1
TEST
L*k*n
L*k*n−1
rold<=rj+thd_off
rold<=rj+thd_off
rold<=rj+thd_off

*FIG.62a*

| TABLE INDEX | TABLE VALUE (dB) |
|---|---|
| 0 | 0.00 |
| 1 | 3.00 |
| 2 | 6.00 |
| 3 | 9.00 |
| 4 | 12.00 |
| 5 | 15.00 |
| 6 | 18.00 |
| 7 | 21.00 |
| 8 | 24.00 |
| 9 | 27.00 |
| 10 | 30.00 |
| 11 | 33.00 |
| 12 | 36.00 |
| 13 | 39.25 |
| 14 | 42.25 |
| 15 | 45.25 |
| 16 | 48.25 |
| 17 | 51.25 |
| 18 | 54.25 |
| 19 | 57.25 |
| 20 | 60.25 |
| 21 | 63.25 |
| 22 | 66.25 |
| 23 | 69.25 |
| 24 | 72.25 |
| 25 | 75.25 |
| 26 | 78.25 |
| 27 | 81.25 |
| 28 | 84.25 |
| 29 | 87.25 |
| 30 | 90.25 |
| 31 | 93.25 |

*FIG.62b*

| TABLE INDEX | TABLE VALUE (dB) |
|---|---|
| 0 | 0.00 |
| 1 | 0.25 |
| 2 | 0.25 |
| 3 | 0.50 |
| 4 | 0.50 |
| 5 | 0.75 |
| 6 | 0.75 |
| 7 | 0.75 |
| 8 | 1.00 |
| 9 | 1.00 |
| 10 | 1.25 |
| 11 | 1.25 |
| 12 | 1.50 |
| 13 | 1.50 |
| 14 | 1.50 |
| 15 | 1.75 |
| 16 | 1.75 |
| 17 | 1.75 |
| 18 | 2.00 |
| 19 | 2.00 |
| 20 | 2.00 |
| 21 | 2.25 |
| 22 | 2.25 |
| 23 | 2.25 |
| 24 | 2.50 |
| 25 | 2.50 |
| 26 | 2.50 |
| 27 | 2.75 |
| 28 | 2.75 |
| 29 | 2.75 |
| 30 | 2.75 |
| 31 | 3.00 |

*FIG.63a*

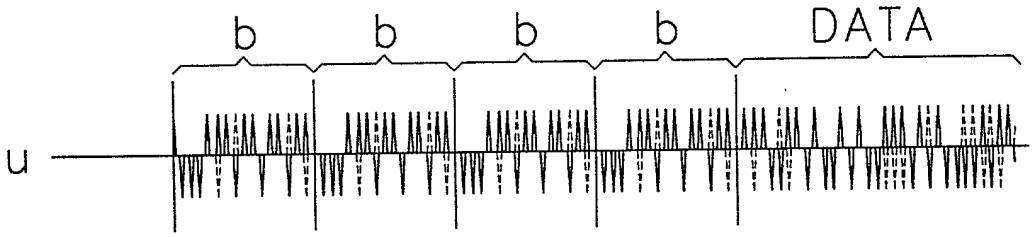



*FIG.63b*

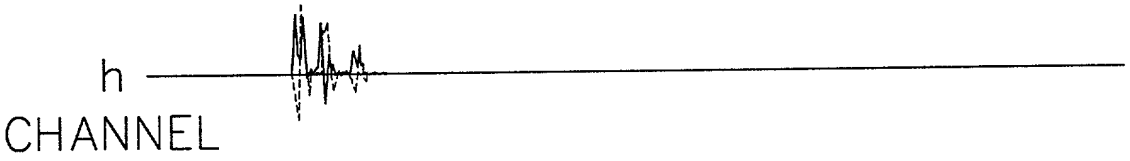



*FIG.63c*

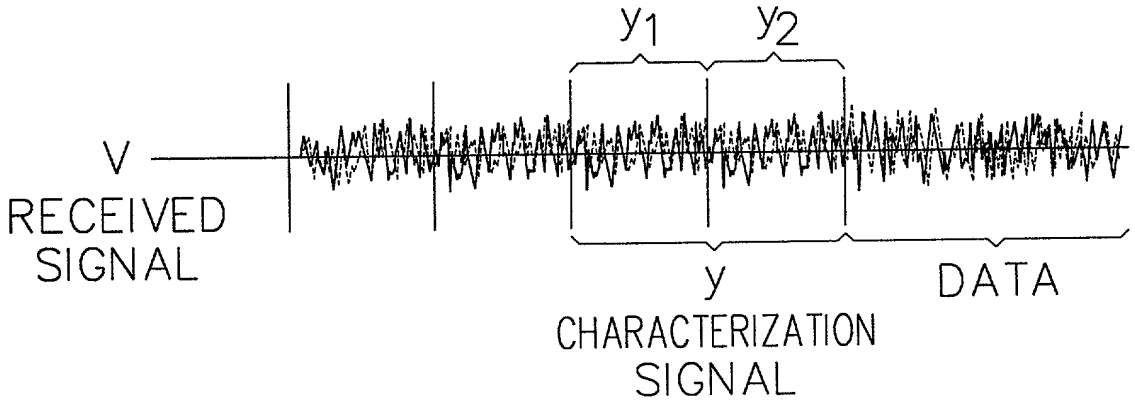


*FIG. 64*

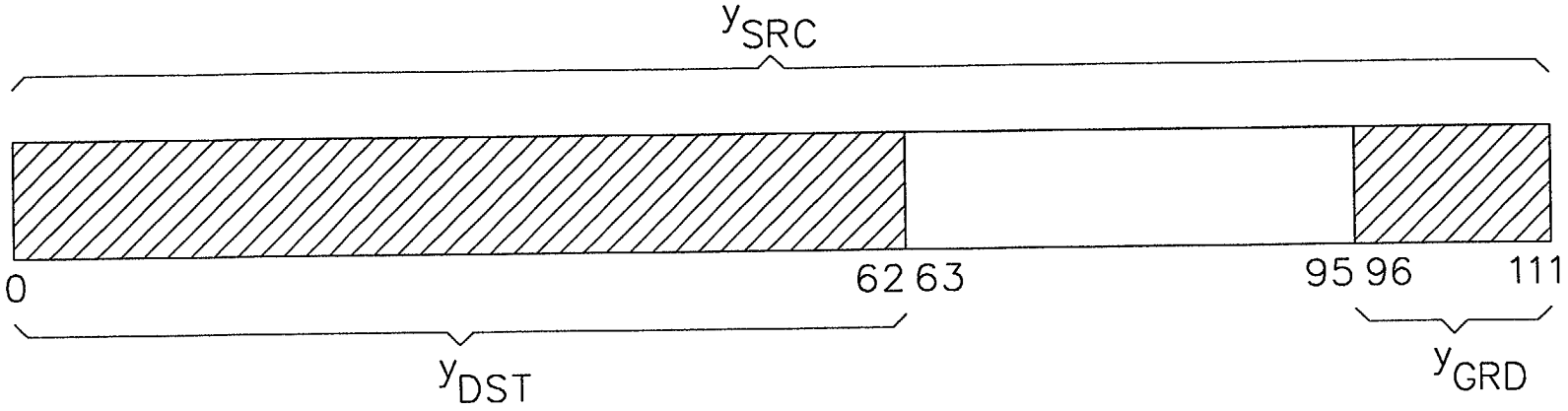

$y_{SRC}$
0
62 63
95 96
111
$y_{DST}$
$y_{GRD}$

*FIG. 65*

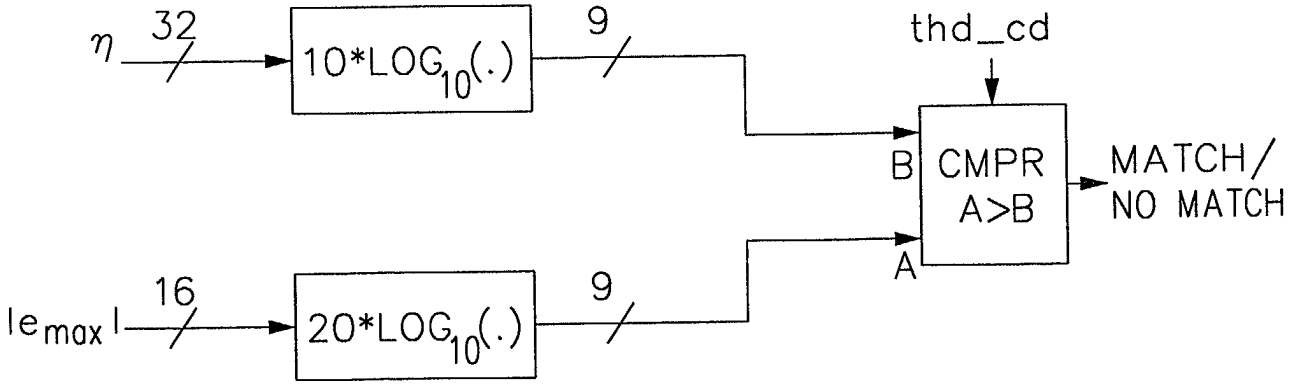

η
32
10*LOG10(.)
9
thd_cd
B
CMPR
A>B
MATCH/
NO MATCH
A
|emax|
16
20*LOG10(.)
9

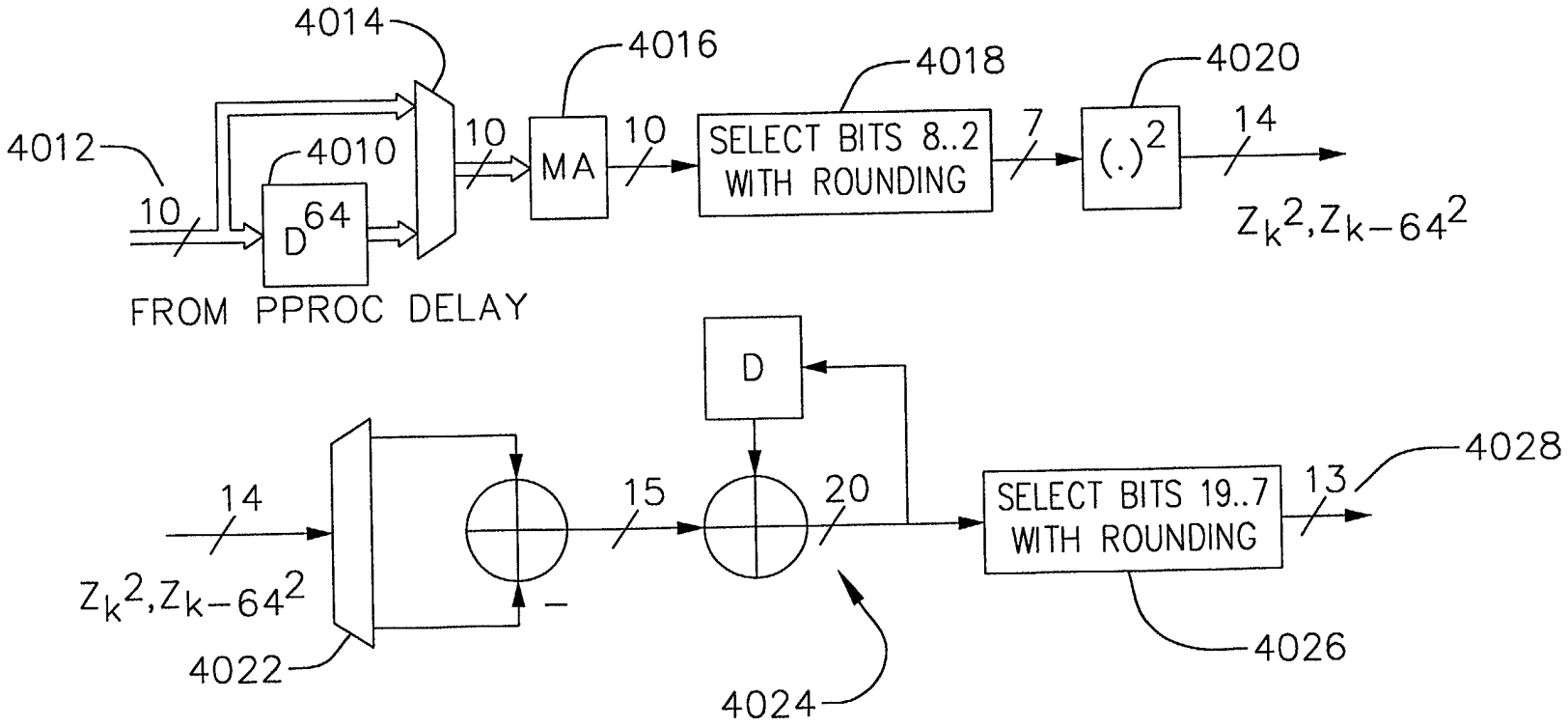
FIG.66a

| TABLE INDEX | TABLE VALUE |
|---|---|
| 0 | 0.00 |
| 1 | 6.00 |
| 2 | 12.00 |
| 3 | 18.00 |
| 4 | 24.00 |
| 5 | 30.00 |
| 6 | 36.00 |
| 7 | 42.25 |
| 8 | 48.25 |
| 9 | 54.25 |
| 10 | 60.25 |
| 11 | 66.25 |
| 12 | 72.25 |
| 13 | 78.25 |
| 14 | 84.25 |
| 15 | 90.25 |

FIG.66b

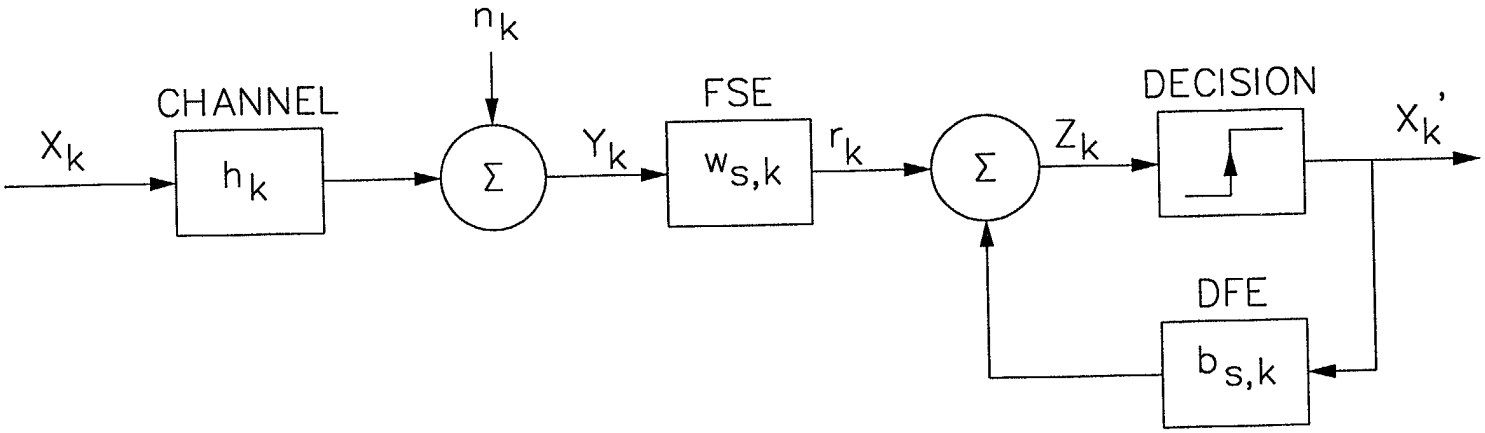
| TABLE INDEX | TABLE VALUE |
|---|---|
| 0 | 0.00 |
| 1 | 0.50 |
| 2 | 1.00 |
| 3 | 1.50 |
| 4 | 2.00 |
| 5 | 2.25 |
| 6 | 2.75 |
| 7 | 3.25 |
| 8 | 3.50 |
| 9 | 4.00 |
| 10 | 4.25 |
| 11 | 4.50 |
| 12 | 4.75 |
| 13 | 5.25 |
| 14 | 5.50 |
| 15 | 5.75 |

*FIG.67*


4014
4016
4018
4020
4012
4010
10
10
10
MA
SELECT BITS 8..2
WITH ROUNDING
7
$(.)^2$
14
$Z_k^2, Z_{k-64}^2$
$D^{64}$
FROM PPROC DELAY
D
14
15
20
13
4028
SELECT BITS 19..7
WITH ROUNDING
$Z_k^2, Z_{k-64}^2$
4022
4024
4026

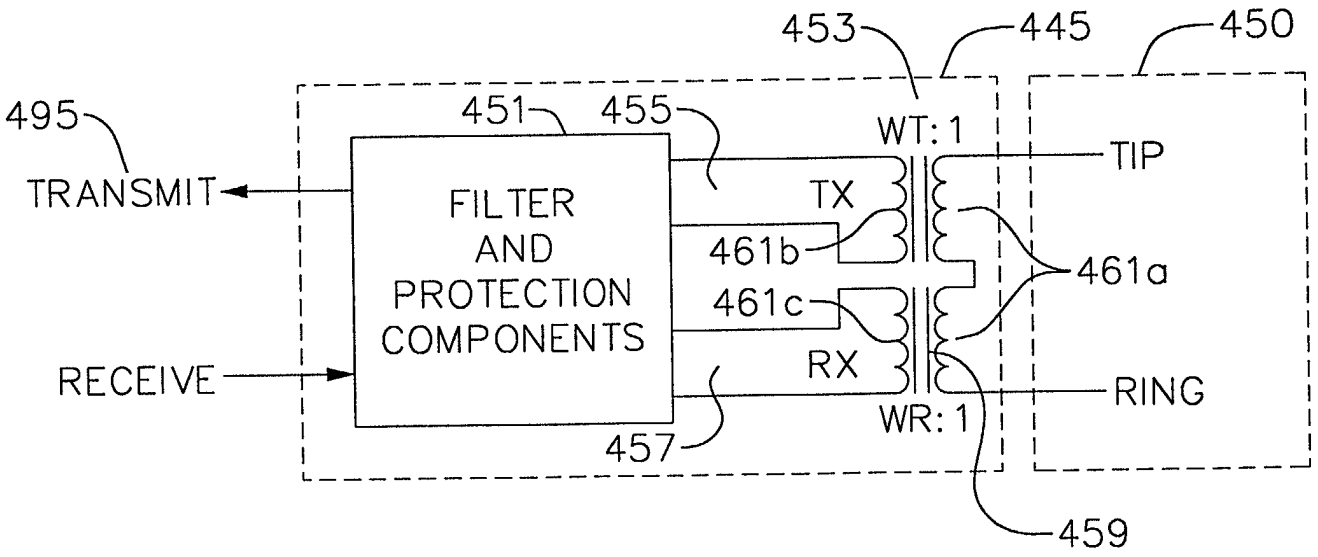
TOSHIBA 6853860

*FIG.68*



TOETZ0"26852660

*FIG.69*



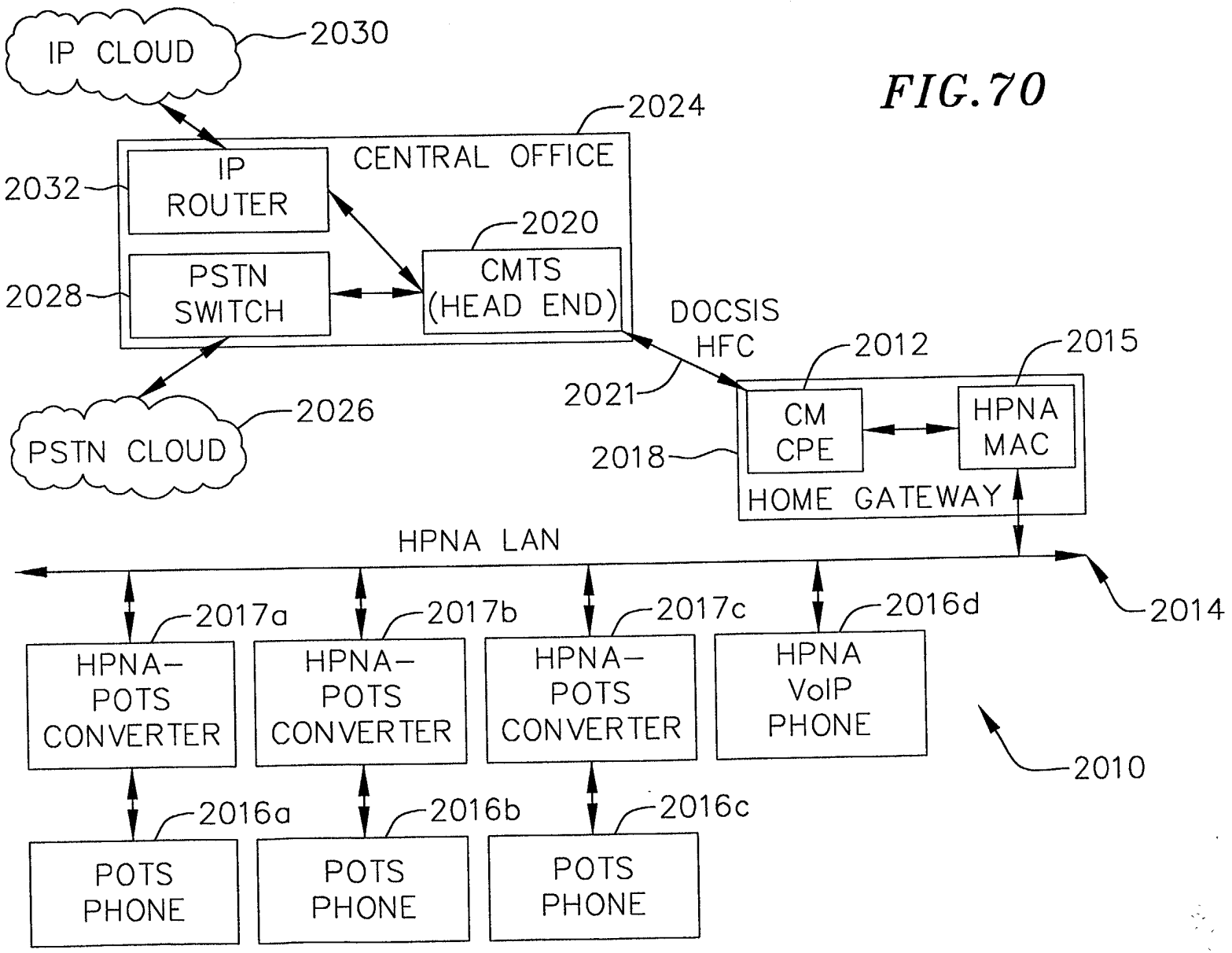

IP CLOUD
2030
2024
CENTRAL OFFICE
IP ROUTER
2032
2020
CMTS (HEAD END)
PSTN SWITCH
2028
DOCSIS HFC
2021
2012
2015
CM CPE
HPNA MAC
2018
HOME GATEWAY
PSTN CLOUD
2026
HPNA LAN
2014
2017a
2017b
2017c
2016d
HPNA– POTS CONVERTER
HPNA– POTS CONVERTER
HPNA– POTS CONVERTER
HPNA VoIP PHONE
2010
2016a
2016b
2016c
POTS PHONE
POTS PHONE
POTS PHONE

*FIG.70*

*FIG.71*

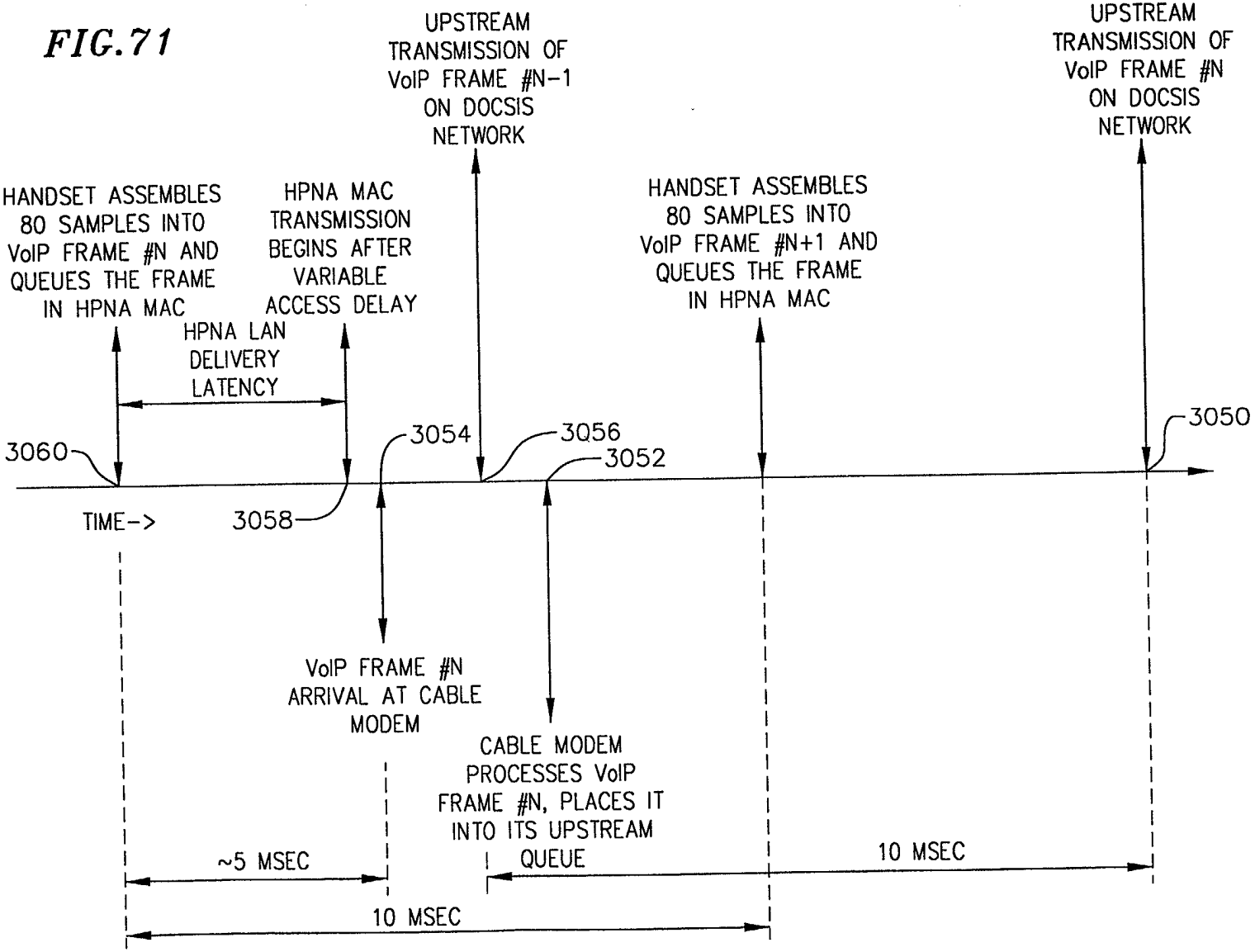

UPSTREAM TRANSMISSION OF VoIP FRAME #N-1 ON DOCSIS NETWORK
UPSTREAM TRANSMISSION OF VoIP FRAME #N ON DOCSIS NETWORK
HANDSET ASSEMBLES 80 SAMPLES INTO VoIP FRAME #N AND QUEUES THE FRAME IN HPNA MAC
HPNA MAC TRANSMISSION BEGINS AFTER VARIABLE ACCESS DELAY
HANDSET ASSEMBLES 80 SAMPLES INTO VoIP FRAME #N+1 AND QUEUES THE FRAME IN HPNA MAC
HPNA LAN DELIVERY LATENCY
3060
3054
3056
3052
3050
3058
TIME->
VoIP FRAME #N ARRIVAL AT CABLE MODEM
CABLE MODEM PROCESSES VoIP FRAME #N, PLACES IT INTO ITS UPSTREAM QUEUE
~5 MSEC
10 MSEC
10 MSEC

FIG. 72a

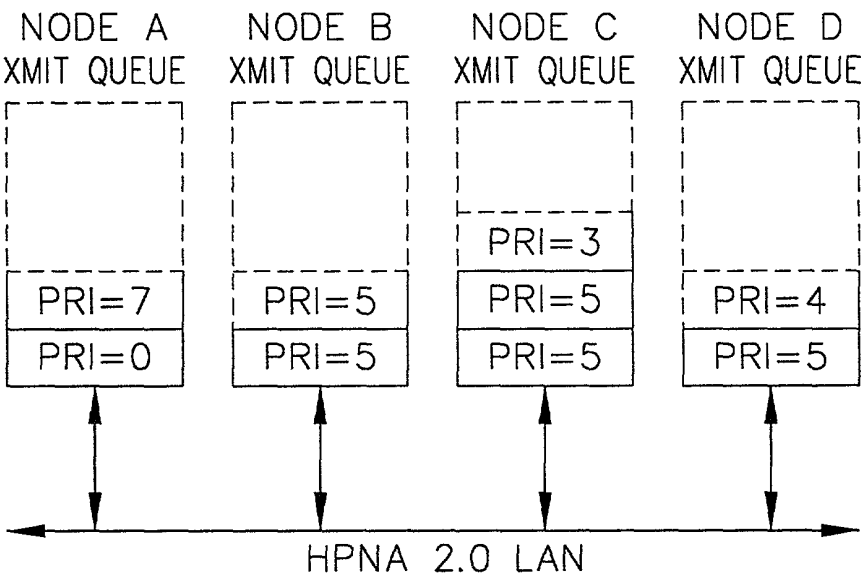



FIG. 72b

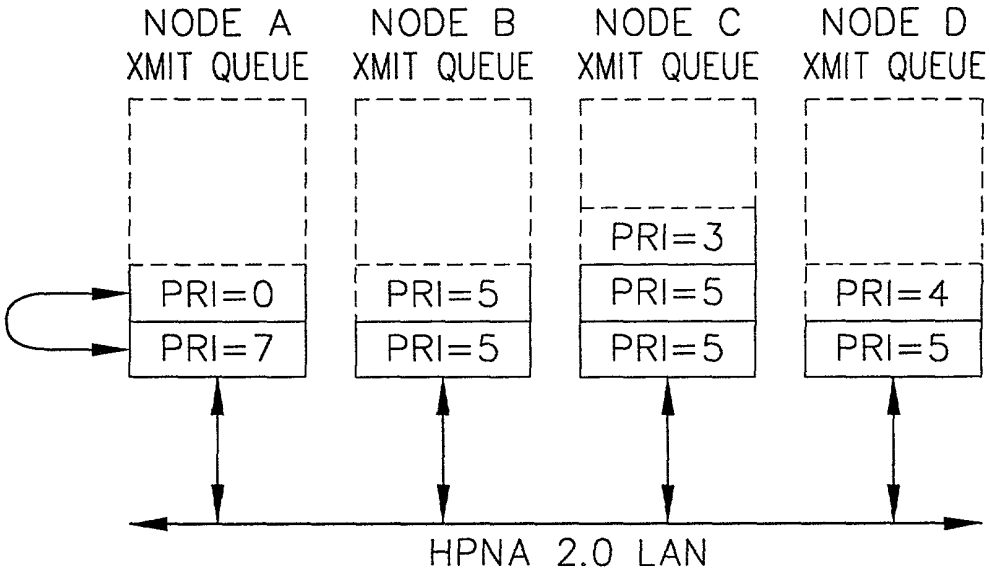


FIG. 73

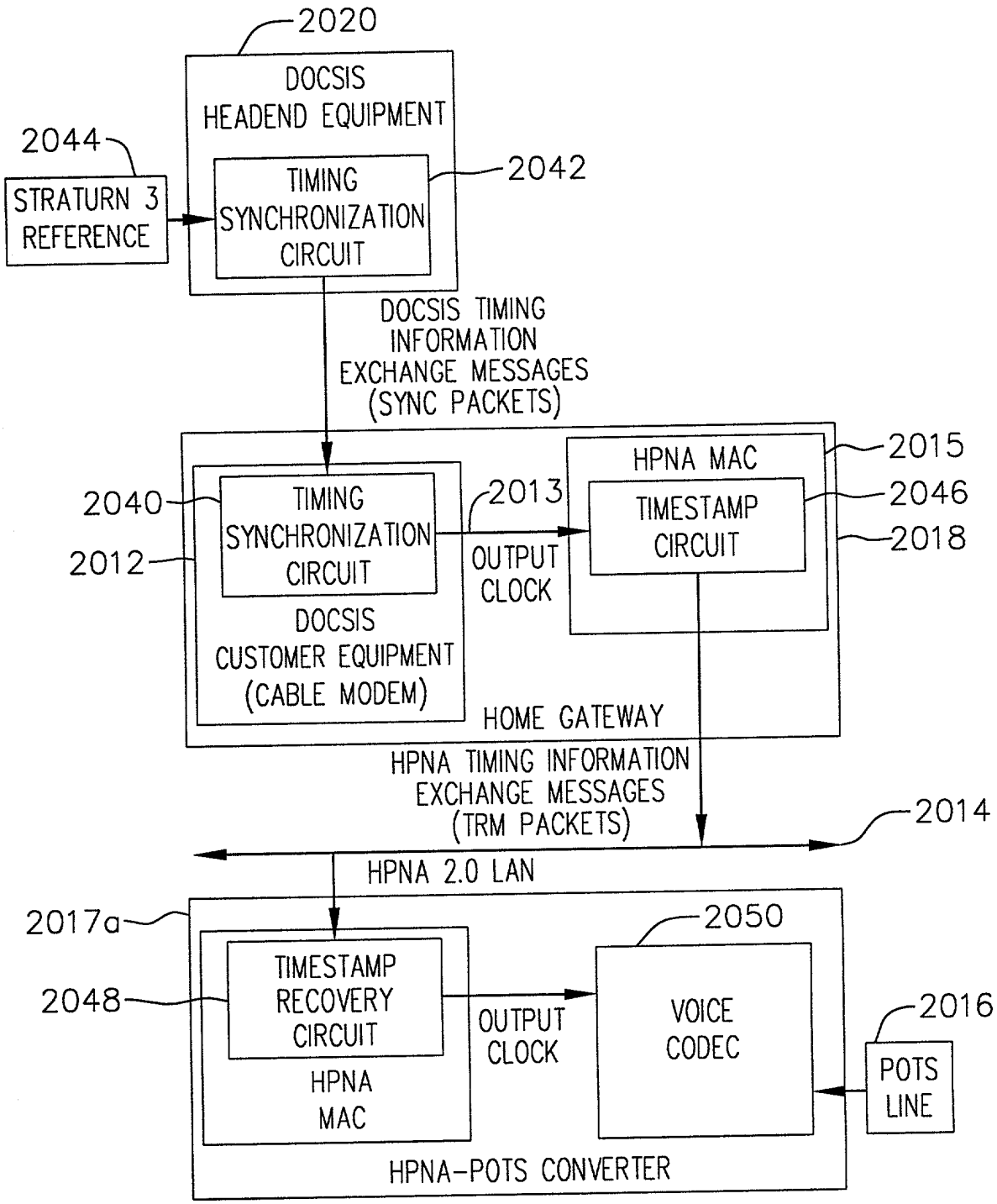

2020
DOCSIS
HEADEND EQUIPMENT
2044
STRATURN 3
REFERENCE
TIMING
SYNCHRONIZATION
CIRCUIT
2042
DOCSIS TIMING
INFORMATION
EXCHANGE MESSAGES
(SYNC PACKETS)
2040
TIMING
SYNCHRONIZATION
CIRCUIT
2012
2013
OUTPUT
CLOCK
HPNA MAC
2015
TIMESTAMP
CIRCUIT
2046
2018
DOCSIS
CUSTOMER EQUIPMENT
(CABLE MODEM)
HOME GATEWAY
HPNA TIMING INFORMATION
EXCHANGE MESSAGES
(TRM PACKETS)
2014
HPNA 2.0 LAN
2017a
2050
TIMESTAMP
RECOVERY
CIRCUIT
2048
OUTPUT
CLOCK
VOICE
CODEC
2016
POTS
LINE
HPNA
MAC
HPNA-POTS CONVERTER

*FIG.74*

| PARAMTER | UPSTREAM "10E-6 CASE | UPSTREAM 91% CASE | UPSTREAM 90% CASE | DOWNSTREAM "10E-6 CASE | DOWNSTREAM 91% CASE | DOWNSTREAM 90% CASE |
|---|---|---|---|---|---|---|
| ACCESS DELAY | 3.1 | 1.3 | 1.3 | 3.1 | 1.3 | 1.3 |
| COLLISION RESOLUTION | 2.7 | 2.7 | 0.8 | 2.7 | 2.7 | 0.8 |
| 3 UP, 1 DOWN | 2.1 | 1.0 | 1.0 | 2.1 | 1.0 | 1.0 |
| LAST UP | 0.5 | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 |
| COLLISION RESOLUTION | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| 3 UP, 1 DOWN | 2.1 | 1.0 | 1.0 | 2.1 | 1.0 | 1.0 |
| LAST UP | 0.5 | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 |
| 3 DOWN | | | | 1.5 | 0.8 | 0.8 |
| 3 DOWN | | | | 1.5 | 0.8 | 0.8 |
| TOTAL LATENCY | 11.8 | 7.4 | 5.5 | 14.9 | 8.9 | 7.1 |

10E-6 CASE IS 10E-6 CRA ONCE OF TWO TRIES IN HOMES WITH MAXIMUM 4MBITS/SEC RAW RATE
91% CASE IS 10E-6 CRA ONCE OF TWO TRIES IN HOMES WITH MINIMUM 10MBITS/SEC RAW RATE
90% CASE IS 10E-1 CRA TWICE IN TWO TRIES IN HOMES WITH MINIMUM 10MBITS/SEC RAW RATE

VALUES IN THE TABLE ABOVE ARE IN MILLISECONDS.

OVERHEADS:

| IFG | PER COLL | FRAME HDR | LARQ HDR | RTP_HDR | LINEAR PCM FRAME SIZE | 5 NODES CRA 10E-6 | 5 NODES CRA 10E-1 | 5 NODES CRA FIXED |
|---|---|---|---|---|---|---|---|---|
| 0.018 | 0.206 | 0.07 | 8 | 40 | 160 | 13 | 4 | 2 |
| MSEC | MSEC | MSEC | BYTES | BYTES | BYTES | COLLISIONS | COLLISIONS | COLLISIONS |

FRAME HEADER INCLUDES PREAMBLE, FC, DA, SA, T/L, EOF

EP0742650A2

*FIG.75*

| | UPSTREAM | | | DOWNSTREAM | | |
|---|---|---|---|---|---|---|
| PARAMTER | "10E-6 CASE | 91% CASE | 90% CASE | "10E-6 CASE | 91% CASE | 90% CASE |
| ACCESS DELAY | 3.1 | 1.3 | 1.3 | 3.1 | 1.3 | 1.3 |
| COLLISION RESOLUTION | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| 3 UP, 1 DOWN | 1.4 | 0.8 | 0.8 | 1.4 | 0.8 | 0.8 |
| LAST UP | 0.5 | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 |
| COLLISION RESOLUTION | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 UP, 1 DOWN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LAST UP | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 DOWN | | | | 1.1 | 0.6 | 0.6 |
| 3 DOWN | | | | 0.0 | 0.0 | 0.0 |
| TOTAL LATENCY | 5.5 | 2.7 | 2.7 | 6.5 | 3.3 | 3.3 |

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Fig. 76

| Field | Length | Meaning |
|---|---|---|
| DA | 6 octets | Destination Address |
| SA | 6 octets | Source Address |
| Ethertype | 2 octets | (TBD) = VOHN Link Control Frame - new IEEE assignment |
| Type | 2 octets | 1 = Timestamp Sync Message |
| Length | 2 octets | = 4 |
| Version | 2 octets | = 0 |
| SeqNum | 2 octets | Timestamp Sync Message Sequence Number |
| Pad | | Any value octet |
| FCS | 4 octets | Frame Check Sequence |

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Fig. 77(1)

| Field | Length | Meaning |
|---|---|---|
| DA | 6 octets | Destination Address |
| SA | 6 octets | Source Address |
| Ethertype | 2 octets | (TBD) = VOHN Link Control Frame - new IEEE assignment |
| Type | 2 octets | 2 = Timestamp Report Message |
| Length | 2 octets | Number of additional octets in the signaling frame, starting with Version field and ending with the last octet of the Data Payload field. Minimum is 2. |
| Version | 2 octets | = 0 |
| TSMSeqNum | 2 octets | Sequence number of TSM to which the Timestamp in this message is applicable. |
| Timestamp | 4 octets | Timestamp of a previously transmitted Timestamp Report Message, corresponding to TSMSeqNum. |
| Frequency | 2 octets | Resolution of the timestamp and Gtimestamp fields, in ticks/1.000ms. For example, value 32768 corresponds to one clock tick at 32.768Mhz, in which the LSBit of the Timestamp corresponds to a time of 0.030517578125usec. The Timestamp will rollover every 131 seconds = 2.2 minutes |
| NumGrants | 2 octets | Number of Grant Timestamps specified in the payload of this control message. NumGrants may be zero. Each grant timestamp is accompanied by a Line ID and Call ID field. Including the Grant Timestamp, the total for each grant timestamp is 8 bytes. |

EXHIBIT 1033

Fig. 77(2)

| | | |
|---|---|---|
| Line ID | 2 octets | Identifier of the Line termination associated with the immediately following GTimestamp. |
| Call ID | 2 octets | Identifier of the call instance on the Line termination associated with the immediately following GTimestamp. |
| GrantTimestamp | 4 octets | Grant Timestamp corresponding to the immediately preceding Line ID. This is the time at which the Proxy Gateway wishes to receive a future constant bit rate service flow packet in order to minimize delivery latency to subsequent delivery to a synchronous network. The time value corresponds to the time at the timing master. Additional packets for the identified service flow are expected to arrive at periodic intervals measured from this time. |
| ••• | | additional instances of {Line ID, Call ID, Grant Timestamp} field tuples |
| Pad | | Any value octet |
| FCS | 4 octets | Frame Check Sequence |

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Fig. 7B

| PIN NAME | CM-side Function (HPNA timing master) | | Handset Function (HPNA timing slave) | |
|---|---|---|---|---|
| DPLL_REF_CLK | DPLL input clock | IN | | |
| Grant[4] | Grant Present Indication | IN | | |
| Grant[3] | Grant SID Value[3] | IN | | |
| Grant[2] | Grant SID Value[2] | IN | | |
| Grant[1] | Grant SID Value[1] | IN | | |
| Grant[0] | Grant SID Value[0] | IN | | |
| V_CLK_OUT | | | DPLL output clock | OUT |
| GPI[0] | | | Grant Present Indication[0] | OUT |
| GPI[1] | | | Grant Present Indication[1] | OUT |

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Fig. 79

| PIN NAME | CM-side Function (HPNA timing master) | | Handset Function (HPNA timing slave) | |
|---|---|---|---|---|
| DPLL_REF_CLK | DPLL input clock | IN | | |
| Grant[4] | Grant Present Indication | IN | | |
| Grant[3] | Grant SID Value[3] | IN | | |
| Grant[2] | Grant SID Value[2] | IN | | |
| Grant[1] | Grant SID Value[1] | IN | | |
| Grant[0] | Grant SID Value[0] | IN | | |
| V_CLK_OUT | | | DPLL output clock | OUT |
| Frame[0] | | | Frame boundary marker[0] | OUT |
| Frame[1] | | | Frame boundary marker[1] | OUT |

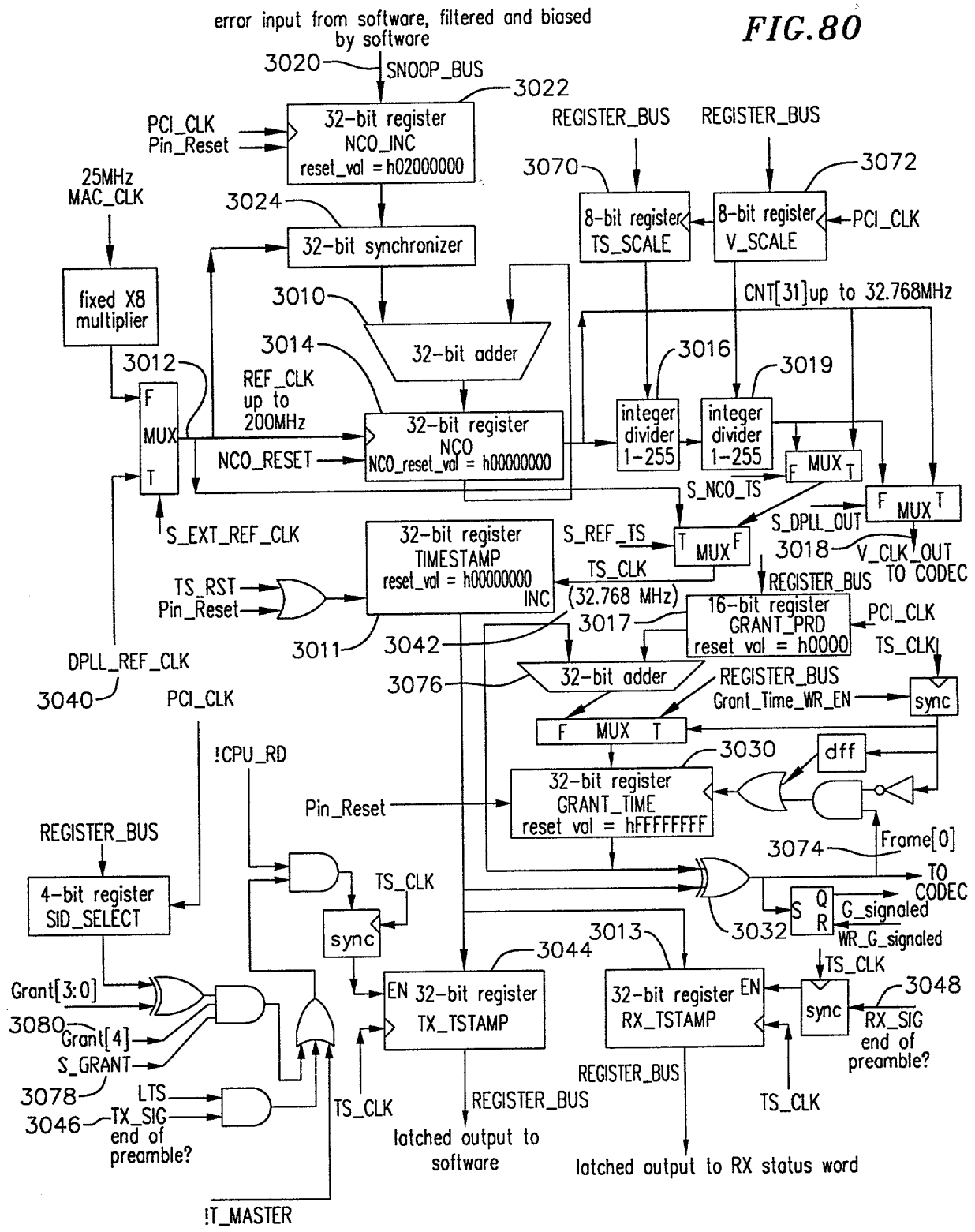
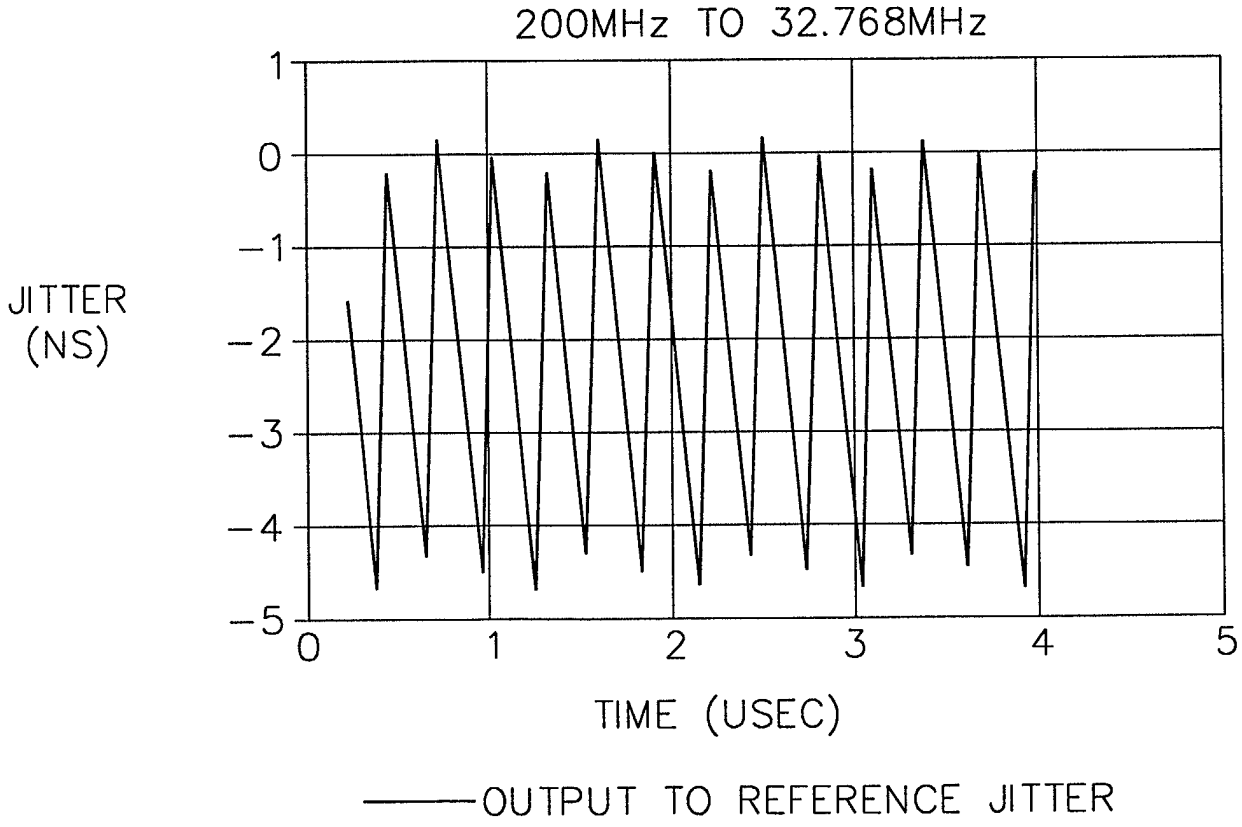

error input from software, filtered and biased by software
3020
SNOOP_BUS
3022
32-bit register
NCO_INC
reset_val = h02000000
PCI_CLK
Pin_Reset
REGISTER_BUS
REGISTER_BUS
3070
3072
8-bit register
TS_SCALE
8-bit register
V_SCALE
PCI_CLK
25MHz
MAC_CLK
3024
32-bit synchronizer
fixed X8
multiplier
3010
32-bit adder
CNT[31]up to 32.768MHz
3012
3014
3016
3019
F
MUX
T
REF_CLK
up to
200MHz
32-bit register
NCO
NCO_reset_val = h00000000
NCO_RESET
integer
divider
1-255
integer
divider
1-255
F MUX T
S_NCO_TS
F MUX T
S_EXT_REF_CLK
32-bit register
TIMESTAMP
reset_val = h00000000
INC
S_REF_TS
T MUX F
S_DPLL_OUT
3018
V_CLK_OUT
TO CODEC
TS_CLK
(32.768 MHz)
REGISTER_BUS
TS_RST
Pin_Reset
3017
16-bit register
GRANT_PRD
reset_val = h0000
PCI_CLK
3011
3042
TS_CLK
DPLL_REF_CLK
3040
PCI_CLK
3076
32-bit adder
REGISTER_BUS
Grant_Time_WR_EN
sync
F MUX T
!CPU_RD
3030
dff
32-bit register
GRANT_TIME
reset_val = hFFFFFFFF
Pin_Reset
REGISTER_BUS
3074
Frame[0]
TO
CODEC
4-bit register
SID_SELECT
TS_CLK
sync
S Q
R
G_signaled
WR_G_signaled
3032
3013
3044
TS_CLK
Grant[3:0]
EN 32-bit register
TX_TSTAMP
32-bit register EN
RX_TSTAMP
sync
3048
3080
Grant[4]
S_GRANT
RX_SIG
end of
preamble?
3078
LTS
3046
TX_SIG
end of
preamble?
TS_CLK
REGISTER_BUS
latched output to
software
REGISTER_BUS
TS_CLK
latched output to RX status word
!T_MASTER

FIG.80

*FIG.81*


200MHz TO 32.768MHz
JITTER (NS)
1
0
−1
−2
−3
−4
−5
0
1
2
3
4
5
TIME (USEC)
——OUTPUT TO REFERENCE JITTER

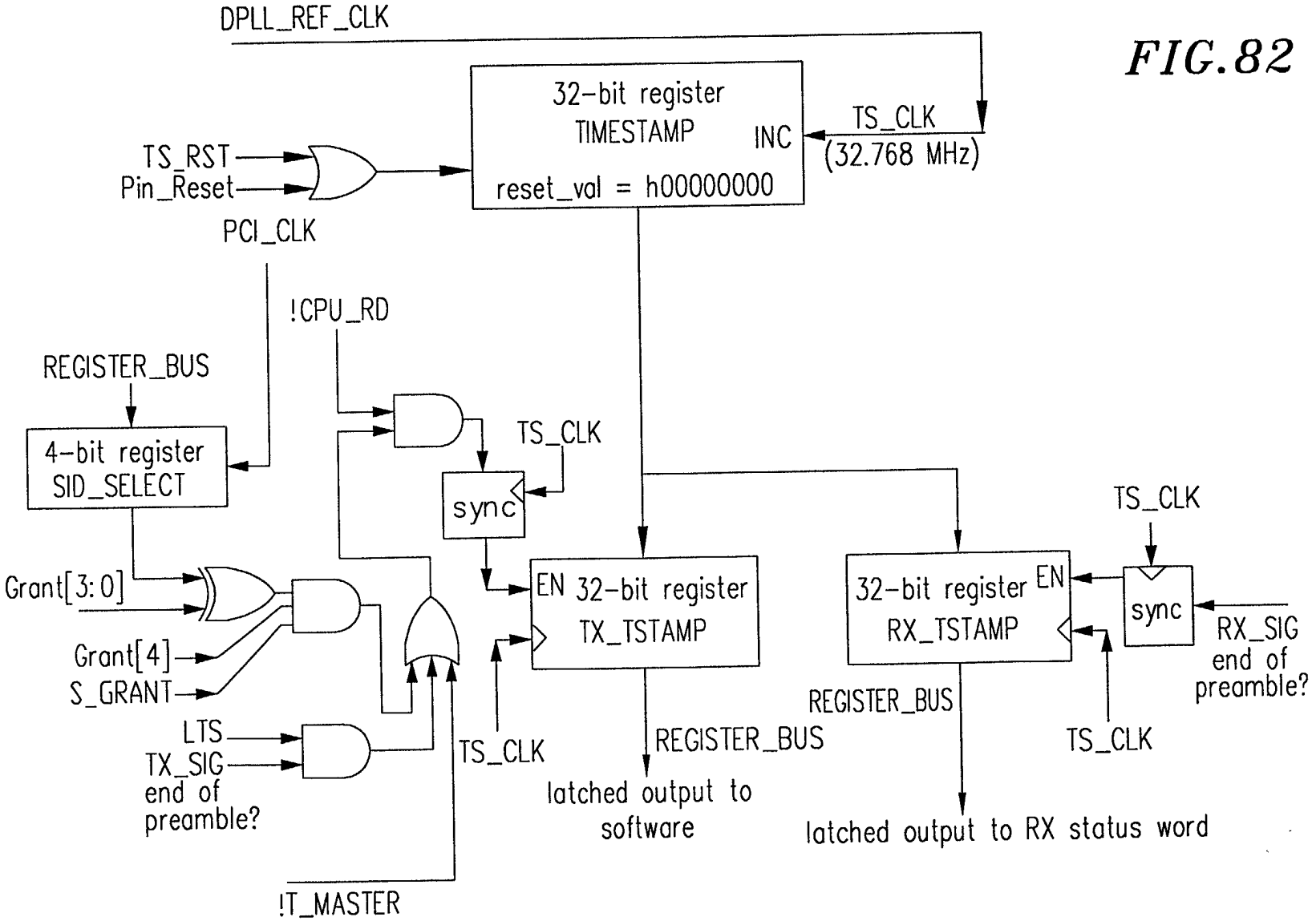

DPLL_REF_CLK
32-bit register
TIMESTAMP
INC
reset_val = h00000000
TS_CLK
(32.768 MHz)
TS_RST
Pin_Reset
PCI_CLK
!CPU_RD
REGISTER_BUS
4-bit register
SID_SELECT
TS_CLK
sync
Grant[3:0]
Grant[4]
S_GRANT
LTS
TX_SIG
end of
preamble?
!T_MASTER
TS_CLK
EN 32-bit register
TX_TSTAMP
REGISTER_BUS
latched output to
software
32-bit register EN
RX_TSTAMP
TS_CLK
sync
RX_SIG
end of
preamble?
REGISTER_BUS
TS_CLK
latched output to RX status word

FIG.82

Fig. 83a

| PIN NAME | CM-side Function (HPNA timing master) | | Handset Function (HPNA timing slave) | |
|---|---|---|---|---|
| DPLL_REF_CLK | Timestamp input clock | IN | Timestamp input clock | |
| Grant[4] | Grant Present Indication | IN | NA | |
| Grant[3] | Grant SID Value[3] | IN | NA | |
| Grant[2] | Grant SID Value[2] | IN | NA | |
| Grant[1] | Grant SID Value[1] | IN | NA | |
| Grant[0] | Grant SID Value[0] | IN | NA | |

EDET/SD-25999-SD

Fig.83b

| Bit locations | Field name | Description |
|---|---|---|
| 7-3 | Reserved | |
| 2 | TsReset | When set to 1, forces timestamp register to value of 0x00000000. When set to 0, allows timestamp register to increment by one for each detected DPLL_REF_CLK rising edge. |
| 1 | SGrant | When set to 1, causes timestamp to be latched into txTimeStampHigh and txTimeStampLow registers whenever the value of tscSID matches the value of input pins Grant[3:0] and Grant[4] is asserted. When set to 0, disables txTimeStampHigh and txTimeStampLow latching under the stated conditions. |
| 0 | TMaster | When set to 1, enables txTimestampHigh and txTimestampLow registers to be latched with timestamp values at times determined by frame transmissions (through the LTS descriptor bit) or grant events (through the sGrant descriptor bit). When set to 0, enables txTimestampHigh and txTimestampLow registers to be latched with timestamp values at times determined by txTimeStampHigh and txTimeStampLow register read accesses. |

Default value of this register is 0x05

| Bit locations | Field name | Description |
|---|---|---|
| 7-4 | Reserved | |
| 3-0 | SID | SID value that is to be matched by Grant[3:0] pins in order to cause a grant timestamp value to be latched. When the Grant[3:0] pins match the SID value and the Grant[4] input is 1 and the sGrant register bit is 1, then the current timestamp value will be latched into the txTimeStampHigh and txTimeStampLow registers. |

Default value of this register is 0x00

Fig.83c

Fig. 83d

| Bit locations | Field name | Description |
|---|---|---|
| 15-0 | txTimeStampLow | Least significant 16 bits of the latched tx timestamp value |

Default value of this register is undefined.

Fig. 83e

| Bit locations | Field name | Description |
|---|---|---|
| 15-0 | txTimeStampHigh | Most significant 16 bits of the latched tx timestamp value |

Default value of this register is undefined.

Fig. 83f

| Bit locations | Field name | Description |
|---|---|---|
| 15-0 | rxTimeStampLow | Least significant 16 bits of the latched rx timestamp value |

Default value of this register is undefined.

Fig 83g

| Bit locations | Field name | Description |
|---|---|---|
| 15-0 | rxTimeStampHigh | Most significant 16 bits of the latched rx timestamp value |

Default value of this register is undefined.

PDOCID: US 2005/0265350 A1

*FIG.84a*

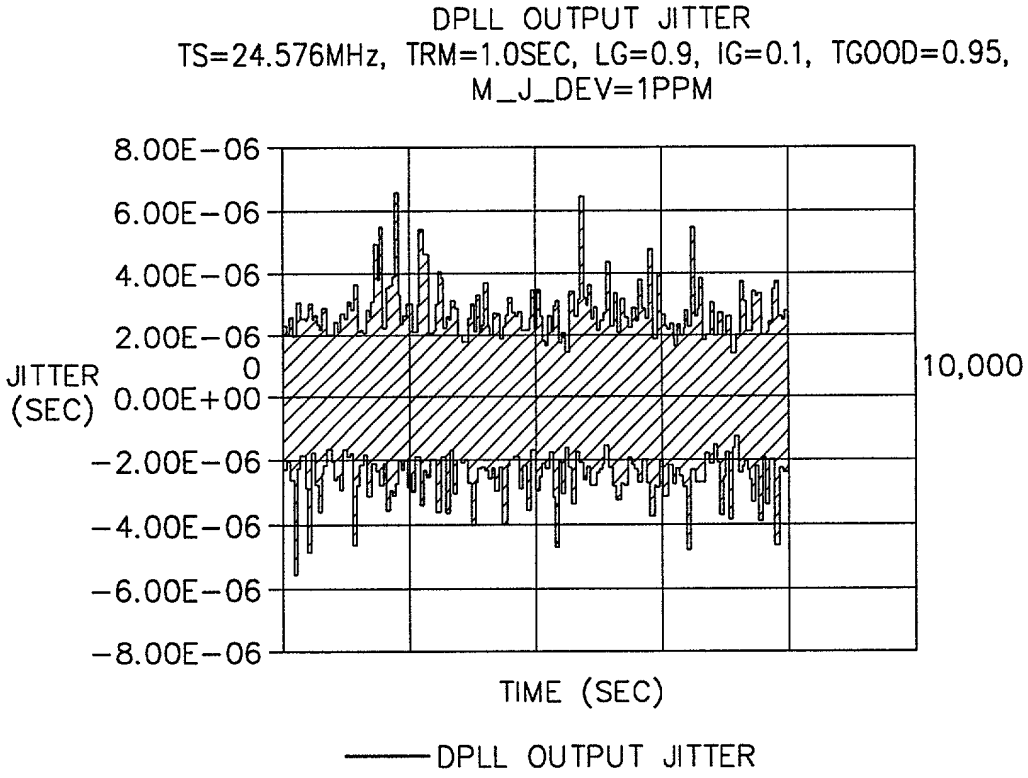



*FIG.84b*

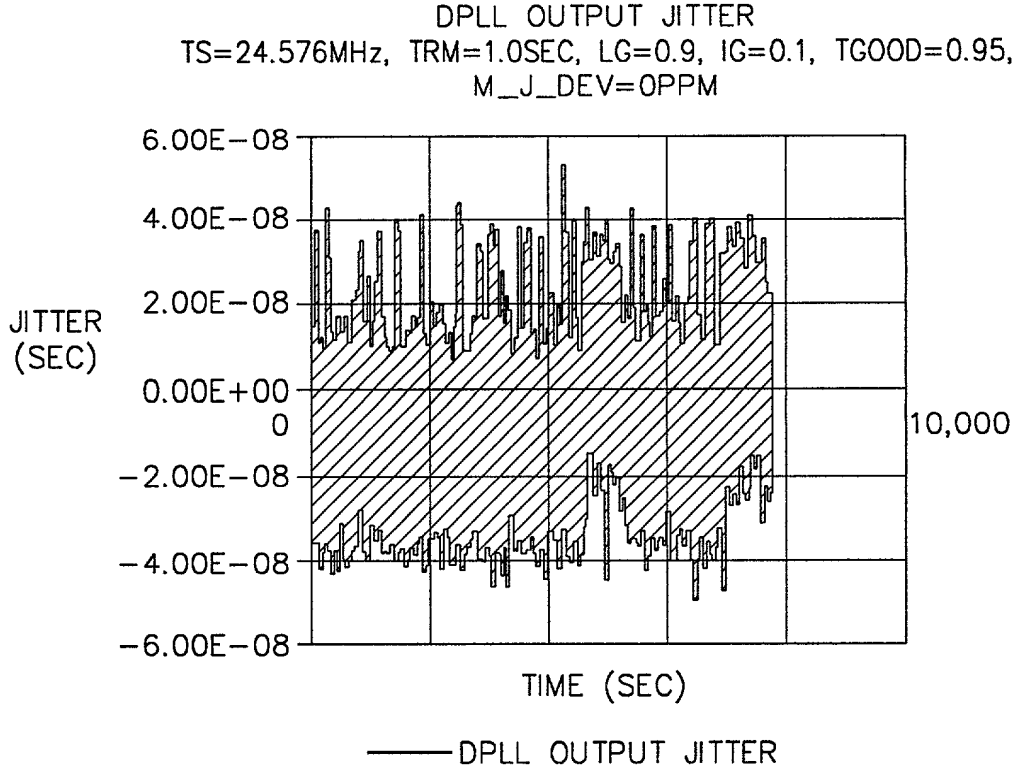


Fig. 85(1)

| Field | Length | Meaning |
|---|---|---|
| DA | 6 octets | Destination Address (FF.FF.FF.FF.FF.FF) |
| SA | 6 octets | Source Address |
| Ethertype | 2 octets | 0x886c (HPNA Link Control Frame) |
| SSType | 1 octet | = TBD |
| SSLength | 1 octet | Number of additional octets in the control header, starting with the SSVersion field and ending with the second (last) octet of the Next Ethertype field. Minimum is 16. |
| SSVersion | 1 octet | = 0 |
| TRM_type | 1 octet | Value of x00 means that this is a TRM containing a valid timestamp. Value of x01 means that the master does not have a valid clock and slaves should give local indication that they are no longer locked to a master reference. Value of x80 means that this is a TQM. Value of x81 means that this is a TSM. All other values are reserved. |
| TRMSeqNum | 2 octets | Timestamp Report Message Sequence Number for this message. Sequence number of x0000 indicates an initial TRM, implying that Timestamp and PrevTRMSeqNum are both invalid. |
| PrevTRMSeqNum | 2 octets | Sequence number of TRM to which the Timestamp in this message is applicable. The value of PrevTRMSeqNum is *not* necessarily equal to TRMSeqNum minus one. PrevTRMSeqNum is set to x0000 for the first TRM of a TRM pair. |

Fig. 85(2)

| Field | Length | Meaning |
|---|---|---|
| Timestamp | 4 octets | Timestamp of a previously transmitted Timestamp Report Message, corresponding to PrevTRMSeqNum. The LSBit of the Timestamp corresponds to a time of 0.030517578125$\mu$sec = one clock tick at 32.768MHz. The Timestamp will rollover every 131 seconds = 2.2 minutes. |
| NumSlots | 1 octet | Number of Slot Timestamps specified in the payload of this control message. NumSlots may be zero. Each Slot Timestamp is accompanied by a MACAddr, and Channel_ID field. Including the Slot Timestamp, each Slot Timestamp is 12 bytes long. |
| PAD_0 | 3 octets | Padding to align to a 32-bit boundary. Always present, even when NumSlots has the value of 0. |
| MACAddr | 6 octets | MAC Address associated with the immediately following Channel_ID and STimestamp. |
| Channel_ID | 2 octets | Identifier for a channel associated with the immediately preceding MACAddr. |
| STimestamp | 4 octets | Slot Timestamp corresponding to the immediately preceding Channel_ID. This is the time at which the TRM sender wishes to receive a future constant bit rate service flow packet in order to minimize overall latency of delivery to a synchronous network. The time value corresponds to the time at the timing master. Additional packets for the identified service flow are expected to arrive at periodic intervals measured from this time. The LSBit of the STimestamp corresponds to a time of 0.030517578125$\mu$sec = one clock tick at 32.768MHz. |
| MACAddr | 6 octets | MAC Address associated with the immediately following Channel-ID and STimestamp. |
| Channel_ID | 2 octets | Identifier for a channel associated with the immediately following Channel_ID and STimestamp. |

Fig. 85(3)

| Field | Length | Meaning |
|---|---|---|
| STimestamp | 4 octets | Slot Timestamp corresponding to the immediately preceding Channel_ID. This is the time at which the TRM sender wishes to receive a future constant bit rate service flow packet in order to minimize overall latency of delivery to a synchronous network. Additional packets for the identified service flow are expected to arrive at periodic intervals measured from this time. The LSBit of the STimestamp corresponds to a time of 0.030517578125$\mu$sec = one clock tick at 32.768 MHz. |
| ••• | | [additional instances of MACAddr, Channel_ID and Gtimestamp fields, until the number of Gtimestamp fields equals NumGrants] |
| Next Ethertype | 2 octets | = 0 |
| Pad | max (0,44-SSLength octets | Any value octet |
| FCS | 4 octets | |

EXHIBIT 1098

Fig. 86

| Field | Length | Meaning |
|---|---|---|
| DA | 6 octets | Destination Address (FF.FF.FF.FF.FF.FF) |
| SA | 6 octets | Source Address |
| Ethertype | 2 octets | 0x886c (HPNA Link Control Frame) |
| SSType | 1 octet | = 6 |
| SSLength | 1 octet | Number of additional octets in the control header, starting with the SSVersion field and ending with the second (last) octet of the Next Ethertype field. Minimum is 4. |
| SSVersion | 1 octet | = 0 |
| TRM_type | 1 octet | Value of x80 means that this is a TQM. |
| Next Ethertype | 2 octets | = 0 |
| Pad | MIN(0,40-SSLength) octets | Any value octet |
| FCS | 4 octets | |

EXHIBIT 2068 - 0086

Fig. 87

| Field | Length | Meaning |
|---|---|---|
| DA | 6 octets | Destination Address (FF.FF.FF.FF.FF.FF) |
| SA | 6 octets | Source Address |
| Ethertype | 2 octets | 0x886c (HPNA Link Control Frame) |
| SSType | 1 octet | = 6 |
| SSLength | 1 octet | Number of additional octets in the control header, starting with the SSVersion field and ending with the second (last) octet of the Next Ethertype field. Minimum is 4. |
| SSVersion | 1 octet | = 0 |
| TRM_type | 1 octet | Value of x81 means that this is a TSM. |
| Next Ethertype | 2 octets | = 0 |
| Pad | MIN(0,40-SSLength) octets | Any value octet |
| FCS | 4 octets | |

*FIG.88*

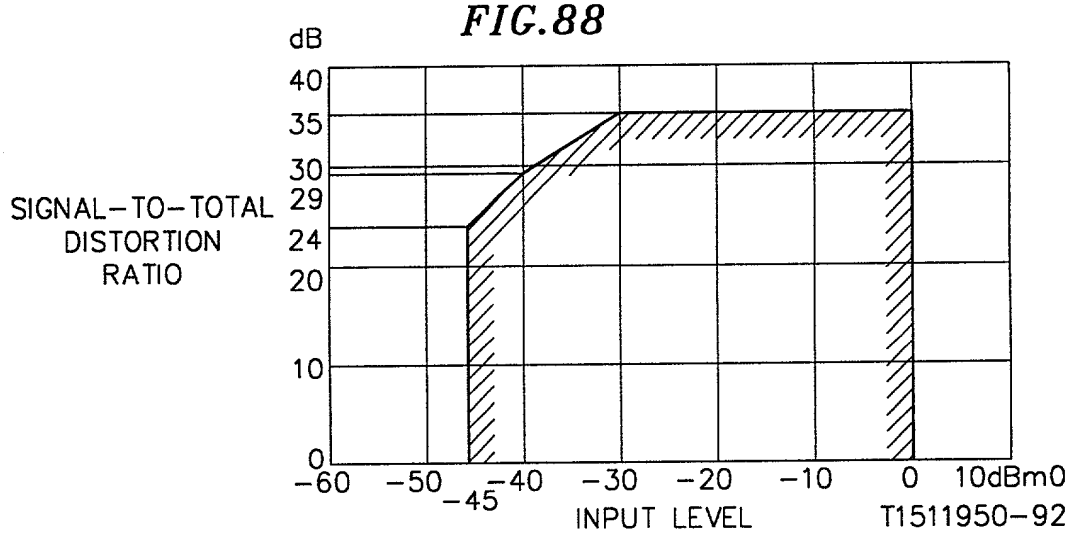



*FIG.89a*

| INPUT LEVEL | UNIFORM QUANTIZER +COMPANDER SNR | THE REQUIRED SNR FOR ADC/DAC |
|---|---|---|
| 0dBm | 38.43dB | 60dB |
| -30dBm | 35.50dB | 54dB |
| -40dBm | 30.09dB | 44dB |

*FIG.89b*

| INPUT LEVEL | G.712 SNR SPEC | THE TOTAL SNR WITH UNIFORM QUANTIZER+COMPANDER+JITTER CLOCK |
|---|---|---|
| 0dBm | 35dB | 38.32dB (60dB ADC/DAC SNR IS USED) |
| -30dBm | 35dB | 35.42dB (54dB ADC/DAC SNR IS USED) |
| -40dBm | 29dB | 30.05dB (44dB ADC/DAC SNR IS USED) |

*FIG.89c*

| INPUT LEVEL | G.712 SNR SPEC | THE TOTAL SNR WITH UNIFORM QUANTIZER+COMPANDER+JITTER CLOCK |
|---|---|---|
| 0dBm | 35dB | 38.38dB (60dB ADC/DAC SNR IS USED) |
| -30dBm | 35dB | 35.26dB (54dB ADC/DAC SNR IS USED) |
| -40dBm | 29dB | 30.03dB (44dB ADC/DAC SNR IS USED) |

FOR EXAMINATION PURPOSES

*FIG.90*

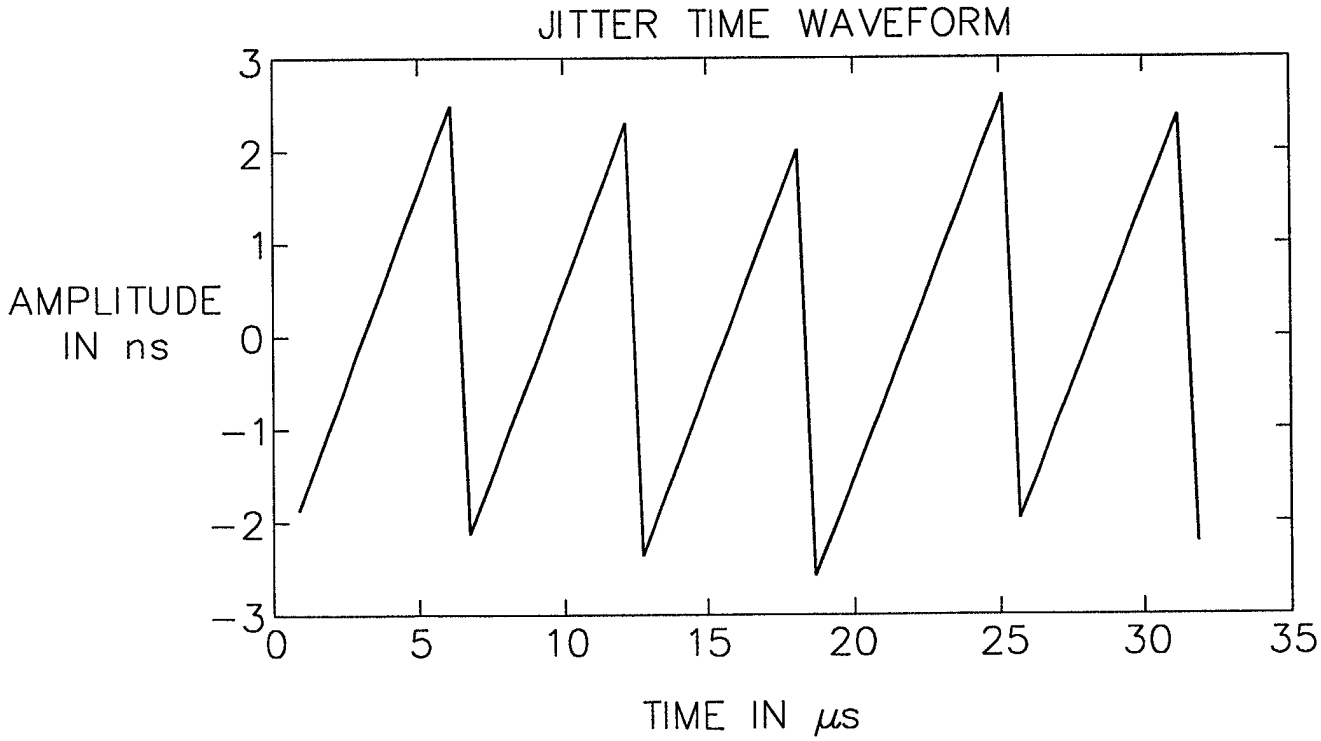

JITTER TIME WAVEFORM
AMPLITUDE IN ns
3
2
1
0
−1
−2
−3
0
5
10
15
20
25
30
35
TIME IN μs

*FIG. 91*

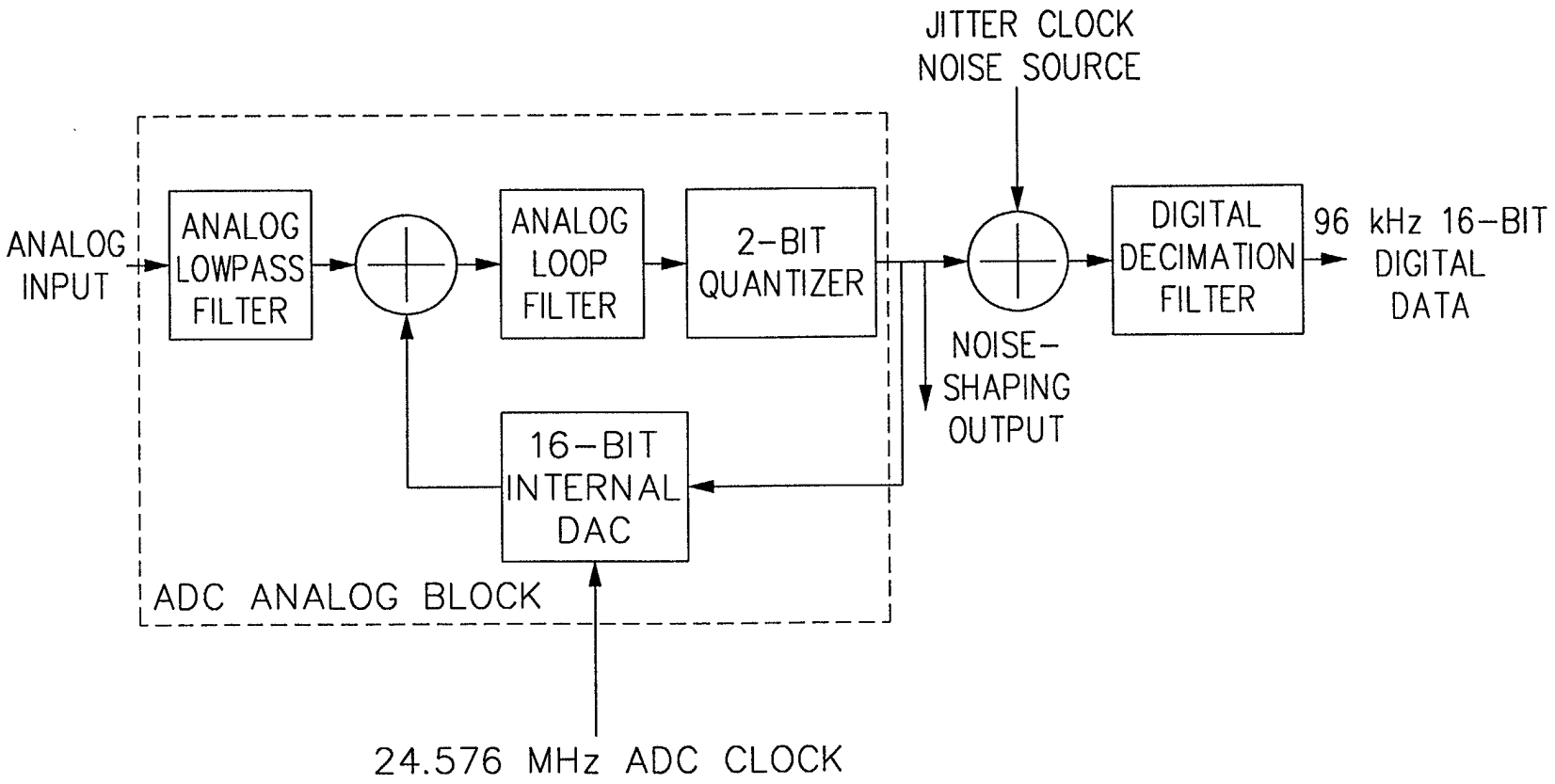

JITTER CLOCK
NOISE SOURCE
ANALOG
INPUT
ANALOG
LOWPASS
FILTER
ANALOG
LOOP
FILTER
2-BIT
QUANTIZER
DIGITAL
DECIMATION
FILTER
96 kHz 16-BIT
DIGITAL
DATA
NOISE-
SHAPING
OUTPUT
16-BIT
INTERNAL
DAC
ADC ANALOG BLOCK
24.576 MHz ADC CLOCK

*FIG. 92*

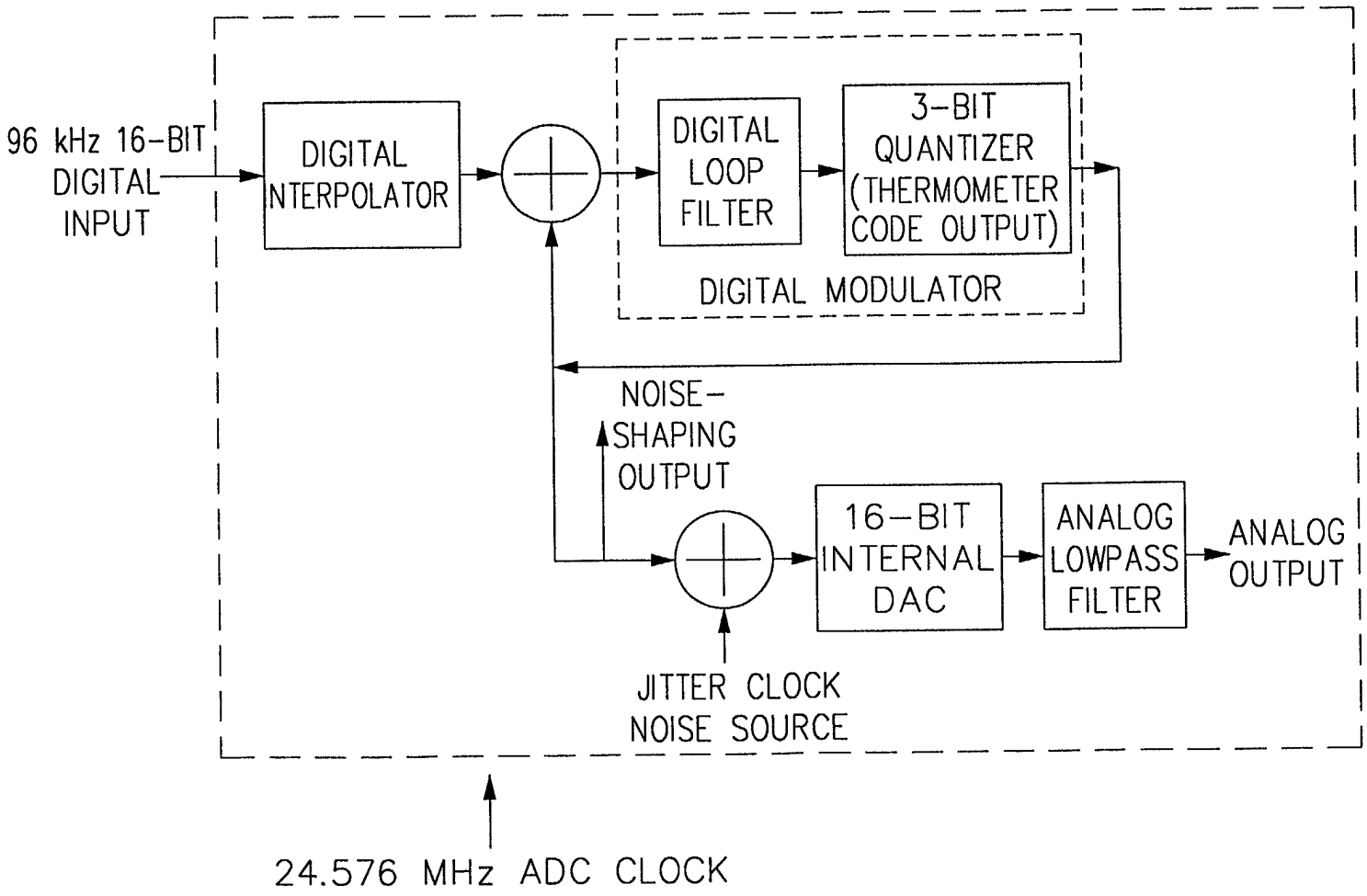

96 kHz 16-BIT DIGITAL INPUT
DIGITAL INTERPOLATOR
DIGITAL LOOP FILTER
3-BIT QUANTIZER (THERMOMETER CODE OUTPUT)
DIGITAL MODULATOR
NOISE-SHAPING OUTPUT
16-BIT INTERNAL DAC
ANALOG LOWPASS FILTER
ANALOG OUTPUT
JITTER CLOCK NOISE SOURCE
24.576 MHz ADC CLOCK

Fig. 93(1)

| Octet | Field | Length | Description |
|---|---|---|---|
| Flags 0 | TxPriority7 | 1 | Station is (was) transmitting frames with LL priority 7. (always set) |
| | TxPriority6 | 1 | Station is (was) transmitting frames with LL priority 6. |
| | TxPriority5 | 1 | Station is (was) transmitting frames with LL priority 5. |
| | TXPriority4 | 1 | Station is (was) transmitting frames with LL priority 4. |
| | TxPriority3 | 1 | Station is (was) transmitting frames with LL priority 3. |
| | TxPriority2 | 1 | Station is (was) transmitting frames with LL priority 2. |
| | TxPriority1 | 1 | Station is (was) transmitting frames with LL priority 1. |
| | TxPriority0 | 1 | Station is (was) transmitting frames with LL priority 0. (always set) |
| Flags 1 | Reserved | 5 | Shall be sent as 0 and ignored by 2.0 stations when received. |
| | CSS_Master_Capability | 1 | This station is capable of operating as a CSS Master node. |
| | No_V1M2_Frames | 1 | This station does not support the reception or transmission of compatibility frames (V1M2 frames). |
| | Supports 4Mbaud | 1 | This station supports 4 megabaud payload encodings. |
| Flags 2 | Reserved | 8 | Shall be sent as 0 and ignored by 2.0 stations when received. |
| Flags 3 | ConfigV2 | 1 | Force use of 10M8 mode, defers to Config1 and ConfigV1Ms. |
| | ConfigV1M2 | 1 | Force use of HPNA V1M2 mixed mode, defers to ConfigV1. |

EXHIBIT 2003

Fig. 93(2)

| Octet | Field | Length | Description |
|---|---|---|---|
| | ConfigV1 | 1 | Force use of HPNA 1.x mode, highest precedence of config flags. |
| | Reserved | 2 | Shall be sent as 0 and ignored by 2.0 stations when received. |
| | Highest Version | 3 | This station's highest supported HPNA version:<br>0x000 -- Reserved<br>0x001 -- HPNA 1.0<br>0x010 -- HPNA 2.0<br>0x001-0x111 Reserved |

EXHIBIT 2068

Fig. 94

| Field | Length | Meaning |
|---|---|---|
| CSEType | 1 octet | X00 = signifies a CSS Extension type |
| CSELength | 1 octet | X08 = Number of additional octets in this CSEType. CSELength is always x08 for CSEType = x00 = CSS |
| CSS_MAC | 6 octets | MAC address of client station |
| CSS_SEQ | 2 octets | CSS sequence, 8 two-bit values concatenated: 0-2 indicate a specific signaling slot, while 3 indicates the use of a randomly selected value chosen by the client at the time of the collision.<br>X0000 - xBFFF = assigned CSS_SEQ value for the node possessing the MAC address specified in CSS_MAC<br>XC000 - xFEFF = reserved<br>XFF00 = indication by the client node specified by CSS_MAC that it is no longer an active sender of link layer priority 6 frames (equivalent to a "0 active channels" indication)<br>XFF01 - xFFFE = request by the client node specified by CSS_MAC for a CSS Sequence from the master node. The 8 Least significant bits indicate the number of active channels which are sending link layer.<br>priority 6 frames for this client.<br>XFFFF - reserved |

Fig. 95

| 2-bit CSS register value (binary) | Signal slot integer (decimal) |
|---|---|
| 00 | 0 |
| 01 | 1 |
| 10 | 2 |
| 11 | Random in range [0,2] |

| Bit Number | Value |
|---|---|
| 7:0 | **Station Type:**<br>0 – HomePNA 1.x station<br>1 – 10M8 station in V1M2 Mode<br>2 – 10M8 station in V1M2 Mode, that has detected a recent 1M8 transmission with PCOM Station Type = 0<br>Other values reserved |
| 31:8 | Reserved, must be 0 on transmission |

Fig. 96

| Precedence | Variable |
|---|---|
| 1 | ConfigV1 |
| 2 | ConfigV1M2 |
| 3 | ConfigV2 |
| 4 | V1_DETECTED |
| 4 | V1_SIGNALED |

Fig. 97